# SECTION 12 36 61 - 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.

### 1.2 SUMMARY

A. Section Includes:

1. Solid surface material countertops.
2. Solid surface vanities.
3. Solid surface material backsplashes.
4. Solid surface material end splashes.
5. Solid surface material apron fronts.
6. Solid surface material sinks.
7. Solid surface window sills.
8. Solid surface adhesives and sealants.

B. Related Requirements:

### 1.3 ACTION SUBMITTALS

A. Product Data: For countertop, wall, and **sill** materials including manufacturer's technical data sheets, and published written instructions.

B. Sustainable Design Submittals:

1. Product Data: For adhesives and sealants, indicating VOC content.
2. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, terminations, and cutouts.

1. Show locations and details of joints.
2. Show direction of directional pattern, if any.

D. Samples for Initial Selection: For each type of material exposed to view. See finish schedule on the drawings.

E. Samples for Verification: For the following products:

1. Countertop material, 6 inches (150 mm) square.
2. Countertop, with front edge **and backsplash**, 8 by 10 inches (200 by 250 mm), of construction and in configuration specified.

F. Certificates: For the following certifications:

1. United States Food and Drug Administration (FDA) compliance for food contact materials described in 21 CFR 174 to 21 CFR 190.
2. New York City material equipment acceptance, MEA 181-96-M.
3. ANSI/NSF 51 "food zone" and FDA "direct-food contact" compliant.
4. UL GREENGUARD® Gold Certified product for low-chemical emissions.

## 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and 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. Manufacturer Qualifications: ISO 9001 quality management system certification for manufacturing facility(ies).

B. 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.

1. Manufacturer-certified fabricator.

C. Installer Qualifications: Manufacturer certified fabricator of countertops.

D. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and installation.

1. Build mockup of typical countertop as **indicated by Architect**.
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 **after base cabinets are installed but** before countertop fabrication is complete.

## 1.8 COORDINATION

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

## 1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer and installer agree to repair or replace sheet material not free from defects in materials, fabrication, or workmanship within specified warranty period.

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

# PART 2 - PRODUCTS

## 2.1 SOLID SURFACE COUNTERTOP AND WALL MATERIALS

A. Composition Solid-Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Wilsonart LLC; or a comparable product by one of the following:

    a. Affinity Surfaces; a brand of Domain Industries, Inc.
    b. Avonite Surfaces.
    c. E. I. du Pont de Nemours and Company.
    d. Formica Corporation.
    e. LG Chemical, Ltd.
    f. Meganite Inc.

2. Thickness: As indicated by product specified on the drawings..
3. Panel Weight: As indicated by product specified on the drawings..
4. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

    a. Flame-Spread Index: **25** or less.
    b. Smoke-Developed Index: **450** or less.

5. Colors and Patterns: **As specified on the drawings.**

## 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: **Premium**

B. Countertops: 1/2-inch (12.7-mm) thick, solid surface material with front edge built up with same material.

C. Backsplashes: **3/4-inch (19-mm)** thick, solid surface material.

D. Fabricate tops with shop-applied edges **and backsplashes** unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

E. Joints: Fabricate countertops without joints.

F. 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.

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, and similar items.
4. Counter-Mounted Cooktops: Prepare countertops in shop for field cutting openings for cooktops. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.

## 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.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "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 (3 mm in 2.4 m), 1/4 inch (6 mm) maximum. Do not exceed 1/64-inch (0.4-mm) difference between planes of adjacent units.

B. Fasten countertops by adhering with 100-percent silicone material in dab format (not bead format) to base units into underside of countertop at 18 to 24 inches (457 to 610 mm) o.c. 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 countertops by adhering with 100-percent silicone material in dab format (not bead format) to base units into underside of countertop at 18 to 24 inches (457 to 610 mm) o.c. Shim as needed to align subtops in a level plane.

D. Secure countertops to subtops or wood-web frame 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. 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.

F. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.16

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# SECTION 142100 ELECTRIC TRACTION ELEVATORS

## PART 1: GENERAL

### 1.1 SUMMARY

A. Section Includes: Electric Traction Elevators.

B. Products Supplied but Not Installed Under this Section:

1. Hoist Beam
2. Pit Ladder
3. Inserts mounted in block walls for rail attachments

C. Work Supplied Under Other Sections:

1. Temporary lighting, including temporary lighting in hoistway for machine space with switch located in hoistway on the strike jamb side of top landing door.
2. Main line disconnects for each elevator.
   a. One fused three phase permanent power in building electrical distribution room
3. Hoistway ventilation shall be in accordance with local and national building code requirements.
4. Guide Rail Support shall be structurally adequate to extend from pit floor to top of hoistway, with spans in accordance with requirements of authority having jurisdiction and final layouts.
5. Removable barricades at all hoistway openings, in compliance with OSHA 29 CFR 1926.502 in addition to any local code requirements.
6. Lifeline attachments capable of withstanding 5000 lb load in accordance with OSHA 29 CFR 1926.502. Provide a minimum of 2 at the top, front of each hoistway.
7. Pit lighting: Fixture with switch and guards. Provide illumination level equal to or greater than that required by ASME A17.1/CSA B44 2000, or applicable version.
8. Control space lighting with switch. Coordinate switch with lighting for machine space as allowable by code.
9. Access Doors: As required for access to governor and/or seismic switch. Access door shall be self-closing, self-locking if necessary and operable from the inside without a key.

D. Related sections:

1. Section 015000 – Temporary Facility and Controls
2. Section 033000 - Cast-in-Place Concrete:
3. Section 042000 - Unit Masonry

4. Section 055000 - Metal Fabrications
5. Section 071600 - Cementitious Waterproofing
6. Section 230000 - Heating, Ventilating, and Air Conditioning
7. Section 260000 - Electrical
8. Section 263000 - Electric Power Generating and Storing Equipment
9. Section 273000 - Voice Communications
10. Section 283100 - Fire Detection and Alarm
11. Section 310000 – Earthwork

E. Industry and government standards:

1. ICC/ANSI A117.1 Accessible and Usable Buildings and Facilities
2. ADAAG - Accessibility Guidelines for Buildings and Facilities
3. ANSI/NFPA 70, National Electrical Code
4. ANSI/NFPA 80, Standard for Fire Doors and Fire Windows
5. ASME/ANSI A17.1, Safety Code for Elevators and Escalators.

## 1.2 DESCRIPTION OF ELEVATOR

A. Elevator Equipment: KONE Machine Room-Less gearless traction elevator

B. Equipment Control: KCM831

C. Drive: Regenerative

D. Quantity of Elevators: 1 Elevator

E. Landings: 2

F. Openings: 2 Front Openings, 0 Back Openings

G. Travel: 16’ 0”

H. Rated Capacity: 5,000 lb

I. Rated Speed: 150 FPM

J. Clear Inside Dimensions: (W x D) 5' 7 3/16" x 8' 9 11/16"

K. Cab Height: 8'

L. Clear height under suspended ceiling: 7'-6"

M. Entrance Width and Type: 54" and Left Opening

N. Entrance Height: 7'-0"

O. Main Power Supply: 208 V Volts + 5%, three-phase

P. Operation: Simplex

Q. Machine Location: Inside the hoistway mounted on car guide rail

R. Control Space Location: Integrated control

S. Elevator Equipment shall conform to the requirements of seismic zone: Non-Seismic

T. Maintenance Service Period: 12 Months

## 1.3 PERFORMANCE REQUIREMENTS

A. Car Performance

1. Car Speed ± 5% of contract speed under any loading condition or direction of travel.

2. Car Capacity: Safely lower, stop and hold (per code) up to 125% of rated load.

B. System Performance

1. Vertical Vibration (maximum): 15 mg ISO187338/ISO 8041 system pk – pk

2. Horizontal Vibration (maximum): 12 mg ISO187338/ISO 8041 system pk – pk

3. Jerk Rate (maximum): 3.3 ft/sec3

4. Acceleration (maximum): 1.3 ft/sec2

5. In Car Noise: 55 dB(A) Maximum

6. Leveling Accuracy: ±0.2 inches

7. Starts per hour (maximum): 240

## 1.4 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit manufacturer's product literature for each proposed system.

1. Cab design, dimensions and layout.

2. Layout, finishes, and accessories and available options.

3. Controls, signals and operating system.

4. Color selection charts for cab and entrances.

C. Shop Drawings:

1. Clearances and travel of car.
2. Clear inside hoistway and pit dimensions.
3. Location and layout of equipment and signals.
4. Car, guide rails, buffers and other components in hoistway.
5. Maximum rail bracket spacing.
6. Maximum loads imposed on building structure.
7. Hoist beam requirements.
8. Location and sizes of access doors.
9. Location and details of hoistway door and frames.
10. Electrical characteristics and connection requirements.

D. Operation and maintenance data:

1. Provide manufacturer's standard maintenance and operation manual.

E. Diagnostic Tools

1. Prior to seeking final acceptance for the completed project as specified by the Contract Documents, the Elevator Contractor shall deliver to the Owner any specialized tool(s) that may be required to perform diagnostic evaluations, adjustments, and/or parametric software changes and/or test and inspections on any piece of control or monitoring equipment installed.

   This shall include any specialized tool(s) required for monitoring, inspection and/or maintenance where the means of suspension other than conventional wire ropes are furnished and installed by the Elevator Contractor. Any and all such tool(s) shall become property of the Owner. Any diagnostic tool provided to the Owner by the Elevator Contractor shall be configured to perform all levels of diagnostics, systems adjustment and parametric software changes which are available to the Elevator Contractor.

   In those cases where diagnostic tools provided to the Owner require periodic recalibration/or re-initiation, the Elevator Contractor shall perform such tasks at no additional cost to the Owner for a period equal to the term of the maintenance agreement from the date of final acceptance of the competed project During those intervals in which the Owner might find it necessary to surrender a diagnostic tool for re-calibration, re-initiation, or repair, the Elevator Contractor shall provide a temporary replacement for the tool at no additional cost to the Owner.

   The Elevator Contractor shall deliver to the Owner, printed instructions for the proper use of any tool that may be necessary to perform diagnostic evaluations, system adjustment, and/or parametric software changes on any unit of microprocessor-based elevator control equipment and means of suspension other than standard elevator steel cables furnished and install by the Elevator Contractor.
   Accompanying the printed instructions shall be any and all access codes, password, or other proprietary information that is necessary to interface with the microprocessor-control equipment.

## 1.5 QUALITY ASSURANCE

A. Manufacturer: Minimum of fifteen years' experience in the fabrication, installation and service of elevators of the type and performance of the specified. The manufacturer shall have a documented quality assurance program.

B. Installer: The equipment manufacturer shall install the elevator.

C. Inspection and Testing: In accordance with requirements of local jurisdiction, obtain required permits, inspections and tests.

## 1.6 DELIVERY, STORAGE AND HANDLING

A. If the construction site is not prepared to receive the elevator equipment at the agreed ship date, the General Contractor shall be responsible for the cost of storage at an approved facility. Additional labor costs for double handling will be the responsibility of the General Contractor.

B. Delivered elevator materials shall be stored in a protected environment in accordance with manufacturer recommendations. A minimum storage area of 10 feet by 20 feet is required adjacent to the hoistway.

## 1.7 WARRANTY

A. Provide manufacturer warranty for a period of one year. The warranty period is to begin upon final acceptance of the Contract. Warranty covers defects in materials and workmanship. Damage due to ordinary use, vandalism, improper or insufficient maintenance, misuse, or neglect do not constitute defective material or workmanship.

## 1.8 MAINTENANCE SERVICE

A. The elevator manufacturer shall provide maintenance service consisting of regular examinations and adjustments of the elevator equipment for a period of 12 Months after date of final acceptance.

Predictive maintenance shall be included for the full maintenance period. This service must be capable of using AI-based analytics to identify potential equipment issues and notifying the elevator provider via an internet connection.

Replacement parts shall be produced by the original equipment manufacturer.

B. Maintenance service to be performed during regular working hours of regular working days and shall include emergency call back service during regular working hours.

C. Maintenance service shall not include adjustments, repairs or replacement of parts due to negligence, misuse, abuse or accidents.

# PART 2: PRODUCTS

## 2.1 MANUFACTURER

A. Provide AC gearless machine room-less elevator systems subject to compliance with the design and performance requirements of this specification. Elevator manufacturers may include but are not limited to one of the following:

1. Basis of Design: KONE Machine Room-Less traction elevators by KONE, Inc.

(www.kone.com).

2. Other acceptable machine room-less products: manufacturer with minimum 15 years' experience in manufacturing, installing, and servicing elevators of the type required for the project.

## 2.2 EQUIPMENT: CONTROL COMPONENTS AND CONTROL SPACE

A. Controller: Provide microcomputer-based control system to perform all functions.

1. All high voltage (110V or above) contact points inside the controller cabinet shall be protected from accidental contact in a situation where the controller doors are open.

2. Controller shall be separated into two distinct halves; Motor Drive side and Control side. High voltage motor power conductors shall be routed and physically segregated from the rest of the controller.

3. Provide a serial cardrack and main CPU board containing a non- erasable EPROM and operating system firmware.

4. Variable field parameters and adjustments shall be contained in a non- volatile memory module.

B. Drive: Provide Variable Voltage Variable Frequency AC drive system to develop high starting torque with low starting current.

C. Controller Location: Locate controller{s} in the front wall integrated with the top landing entrance frame, machine side of the elevator. One non-fused three phase permanent power in hoist way at top landing. A separate control space should not be required.

## 2.3 EQUIPMENT: HOISTWAY COMPONENTS

A. Machine: AC gearless machine, with permanent magnet synchronous motor, direct current electro-mechanical disc brakes and integral traction drive sheave, mounted to the car guide rail at the top of the hoistway

B. Governor: Friction type over-speed governor rated for the duty of the elevator specified.

C. Buffers, Car and Counterweight: Polyurethane buffer.

D. Hoistway Operating Devices:

1. Emergency stop switch in the pit

2. Terminal stopping switches.

3. Emergency stop switch on the machine

E. Positioning System: System consisting of magnets and proximity switches.

F. Guide Rails and Attachments: Steel rails with brackets and fasteners.

## 2.4 EQUIPMENT: HOISTWAY ENTRANCES

A. Hoistway Entrances

1. Sills: Extruded Aluminum.

2. Doors: Hollow metal construction with vertical internal channel reinforcements.

3. Fire Rating: Entrance and doors shall be UL fire-rated for 1-1/2 hour.

4. Entrance Finish: Brushed Stainless Steel.

5. Entrance Markings Jamb Plates: Provide standard entrance jamb tactile markings on both jambs, at all floors. Plate Mounting: Refer to manufacturer drawings.

## 2.5 EQUIPMENT: CAR COMPONENTS

A. Car Frame: Provide car frame with adequate bracing to support the platform and car enclosure.

B. Car Safeties: Device will be provided and mounted under the car platform, securely bolted to the Car Frame. The safety will be actuated by a centrifugal governor mounted at the top of the hoistway. The Safety is designed to operate in case the car attains excessive descending speed.

C. Platform: Platform shall be all steel construction.

D. Car Guides: Provide guide-shoes mounted to top and bottom of both car and counterweight frame. Each guide-shoe assembly shall be arranged to maintain constant contact on the rail surfaces. Provide retainers in areas with Seismic design requirements.

E. Car Wall Finish:

1. Side Walls: Scottish Quad Textured Stainless Steel (K)

2. Rear Wall: Scottish Quad Textured Stainless Steel (K)

3. Car front, Door and Skirting: Brushed Stainless Steel

4. Ceiling: Round, LED spotlights

5. Handrails: Brushed Stainless Steel

   a. Rails to be located on Side Walls of car enclosure.

6. Sills: Aluminum extruded.

F. Cab Wall Protection Pads to be included

G. Flooring: By others. (Not to exceed 6lb/sqft and 1/2" finished depth.)

H. Emergency Car Signals

1. Emergency Siren: Siren mounted on top of cab that is activated when the alarm button in the car operating panel is engaged. Siren shall have rated sound pressure level of 80 dB(A) at a distance of three feet from device. Siren shall respond with a delay of not more than one second after activation of alarm button.

2. Emergency Car Lighting: Provide emergency power unit employing a 12- volt sealed rechargeable battery and totally static circuits shall illuminate the elevator car and provide current to the alarm bell in the event of building power failure.

3. Emergency Exit Contact: An electrical contact shall be provided on the car-top exit.

I. Ventilation: Manufacturer's standard cab fan

## 2.6 EQUIPMENT: SIGNAL DEVICES AND FIXTURES

A. Car Operating Panel: Provide car operating panel with all push buttons, key switches, and message indicators for elevator operation. Fixture finish to be Brushed Stainless Steel

1. Main Flush mounted car operating panel shall contain a bank of round, mechanical, illuminated buttons marked to correspond to landings served, emergency call button, door open button, door close button, and key switches for lights, inspection, and exhaust fan. Buttons have Amber Dot Matrix illumination (halo). All buttons to have raised text and Braille marking on left hand side. The car operating display panel shall be Amber Dot Matrix. All texts, when illuminated, shall be Amber Dot Matrix. The car operating panel shall have a Brushed Stainless Steel finish.

2. Additional features of car operating panel shall include:

a. Car Position Indicator within operating panel Brushed Stainless Steel

b. Elevator Data Plate marked with elevator capacity and car number on car top.

c. Help buttons with raised markings.

d. In car stop switch per local code.

e. Call Cancel Button.

B. Hall Fixtures: Wall mounted hall fixtures shall be provided with necessary push buttons and key switches for elevator operation. Wall mounted hall fixtures shall have a Brushed Stainless Steel finish.

1. Vandal Resistant hall fixtures shall feature round, mechanical, buttons in applied mount face frame. Hall fixtures shall correspond to options available from that landing. Buttons shall be in a vertically mounted fixture.

C. Car Lantern and Chime: A directional lantern visible from the corridor shall be provided in the car entrance. When the car stops and the doors are opening, the lantern shall indicate the direction in which the car is to travel, and a chime will sound. The chime will sound once for up and twice for down. The car riding lantern face plate shall have a Brushed Stainless Steel finish.

## 2.7 EQUIPMENT: ELEVATOR OPERATION AND CONTROLLER

A. Elevator Operation

1. Simplex Collective Operation: Using a microprocessor-based controller, operation shall be automatic by means of the car and hall buttons. If all calls in the system have been answered, the car shall park at the last landing served.

2. Zoned Car Parking.

3. Relative System Response Dispatching.

B. Standard Operating Features to include:

1. Full Collective Operation

2. Fan and Light Control.

3. Load Weighing Bypass.

4. Ascending Car Uncontrolled Movement Protection

5. Top of Car Inspection Station.

C. Additional Operating Features to include:

1. Independent Service.
2. Hoistway Access Bottom Landing.
3. Hoistway Access Top Landing.
4. Car Wall Protection Pads
5. Provision for Card Reader in Car (Card Reader provided and Installed by others).

6. Emergency Battery Power Supply
   a. When the main line power is lost for longer than 5 seconds the emergency battery power supply provides power automatically to the elevator controller. The elevator will rise or lower to the first available landing, open the doors, and shut down. The elevator will return to service upon the return of normal main line power. An auxiliary contact on the main line disconnect and shunt trip breaker (if required) shall be provided by others.

D. Elevator Control System for Inspections and Emergency

1. Provide devices within controller to run the elevator in inspection operation.

2. Provide devices on car top to run the elevator in inspection operation.

3. Provide within controller an emergency stop switch to disconnect power from the brake and prevents motor from running.

4. Provide the means from the controller to mechanically lift and control the elevator brake to safely bring car to nearest available landing when power is interrupted.

5. Provide the means from the controller to reset the governor over speed switch and also trip the governor.

6. Provide the means from the controller to reset the emergency brake when set because of an unintended car movement or ascending car over speed.

7. Provide the means for the control to reset elevator earthquake operation.

## 2.8 EQUIPMENT: DOOR OPERATOR AND CONTROL

A. Door Operator: A closed loop permanent magnet VVVF high-performance door operator shall be provided to open and close the car and hoistway doors simultaneously. Door movement shall be cushioned at both limits of travel. Electro-mechanical interlock shall be provided at each hoistway entrance to prevent operation of the elevator unless all doors are closed and locked. An electric contact shall be provided on the car at each car entrance to prevent the operation of the elevator unless the car door is closed.

B. The door operator shall be arranged so that, in case of interruption or failure of electric power, the doors can be readily opened by hand from within the car, in accordance with applicable code. Emergency devices and keys for opening doors from the landing shall be provided as required by local code.

C. Doors shall open automatically when the car has arrived at or is leveling at the respective landings. Doors shall close after a predetermined time interval or immediately upon pressing of a car button. A door open button shall be provided in the car. Momentary pressing of this button shall reopen the doors and reset the time interval.

D. Door hangers and tracks shall be provided for each car and hoistway door. Tracks shall be contoured to match the hanger sheaves. The hangers shall be designed for power operation with provisions for vertical and lateral adjustment. Hanger sheaves shall have polyurethane tires and pre-lubricated sealed-for-life bearings.

E. Electronic Door Safety Device. The elevator car shall be equipped with an electronic protective device extending the full height of the car. When activated, this sensor shall prevent the doors from closing or cause them to stop and reopen if they are in the process of closing. The doors shall remain open as long as the flow of traffic continues and shall close shortly after the last person passes through the door opening.

## PART 3: EXECUTION

### 3.1 EXAMINATION

A. Field measure and examine substrates, supports, and other conditions under which elevator work is to be performed.

B. Do not proceed with work until unsatisfactory conditions are corrected.

C. Prior to start of work, verify hoistway is in accordance with shop drawings. Dimensional tolerance of hoistway from shop drawings: -0 inches +2 inches. Do not begin work of this section until dimensions are within tolerances.

D. Prior to start of work, verify projections greater than two inches (four inches if ASME A17.1/CSA B44 2000 applies) must be beveled not less than 75 degrees from horizontal.

E. Prior to start of work, verify landings have been prepared for entrance sill installation. Traditional sill angle or concrete sill support shall not be required.

F. Prior to start of work, verify elevator pit has been constructed in accordance with requirements, is dry and reinforced to sustain vertical forces, as indicated in approved submittal. Verify that sumps or sump pumps located within pit will not interfere with installed elevator equipment.

G. Prior to start of work, verify control space has been constructed in accordance with requirements, with access coordinated with elevator shop drawings, including sleeves and penetrations.

H. Verify installation of GFCI protected 20-amp in pit and adjacent to each signal control cabinet in control space.

## 3.2 PREPARATION

A. Coordinate installation of anchors, bearing plates, brackets and other related accessories.

## 3.3 INSTALLATION

A. Install equipment, guides, controls, car and accessories in accordance with manufacturer installation methods and recommended practices.

B. Properly locate guide rails and related supports at locations in accordance with manufacturer's recommendations and approved shop drawings. Anchor to building structure using isolation system to minimize transmission of vibration to structure.

C. All hoistway frames shall be securely fastened to fixing angles mounted in the hoistway. Coordinate installation of sills and frames with other trades.

D. Lubricate operating system components in accordance with manufacturer recommendations.

E. Perform final adjustments, and necessary service prior to final acceptance.

## 3.4 CONSTRUCTION

A. Interface with Other Work:

1. Guide rail brackets attached to steel shall be installed prior to application of fireproofing.

2. Coordinate construction of entrance walls with installation of door frames and sills. Maintain front wall opening until elevator equipment has been installed.

3. Ensure adequate support for entrance attachment points at all landings.

4. Coordinate wall openings for hall push buttons, signal fixtures and sleeves. Each elevator requires sleeves within the hoistway wall.

5. Coordinate emergency power transfer switch and power change pending signals as required for termination at the primary elevator signal control cabinet in each group.

6. Coordinate interface of elevators and fire alarm system.

7. Coordinate interface of dedicated telephone line.

## 3.5 TESTING AND INSPECTIONS

A. Perform recommended and required testing in accordance with authority having jurisdiction

B. Obtain required permits and provide originals to Owner's Representative.

## 3.6 DEMONSTRATION

A. Prior to final acceptance, instruct Owner's Representative on the proper function and required daily maintenance of elevators. Instruct personnel on emergency procedures.

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# SECTION 21 13 00 – BUILDING SPRINKLER AND STANDPIPE SYSTEMS

1 GENERAL

1.1 Drawings and General provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-23 Basic Mechanical Requirements and Basic Mechanical Materials and Methods sections apply to work of this section.

1.3 Extent of fire protection work is indicated on drawings and schedules, and by requirements of this section.

1.4 Refer to Division-2 sections for site fire protection piping and appurtenances; not work of this section.

1.5 Refer to other Division-21 sections for fire pumps and appurtenances; not work of this section.

1.6 Refer to Division-9 sections for painting of fire protection piping; not work of this section.

1.7 Refer to Division-26 sections for the following work; not work of this section.

1.7.1 Power supply wiring from power source to power connection on air compressors and local alarm bells. Include disconnects and required electrical devices, except where specified as furnished or factory-installed by manufacturer.

1.7.2 Fire alarm connections for all flow switches, pressure switches, and supervisory (tamper) switches.

1.8 Quality Assurance: The Sprinkler Contractor shall be qualified as follows:

1.8.1 Experience: Contractor shall have a minimum of ten years continuous experience.

1.8.2 Home Office: The home office for the contractor shall be located within 125 miles of the project site.

1.9 Codes and Standards:

1.9.1 NFPA Compliance: Install fire protection systems in accordance with NFPA 13 "Standard for the Installation of Sprinkler Systems" and NFPA 14 "Standard for the Installation of Standpipe and Hose Systems".

1.9.2 UL Compliance: Provide fire protection products in accordance with UL standards; provide UL label on each product.

1.9.3 Fire Department/Marshal Compliance: Install fire protection systems in accordance with

local regulations of fire department or fire marshal.

1.9.4 Screw Thread Connections: Comply with local Fire Department/Fire Marshal regulations for sizes, threading and arrangement of connections for fire department equipment to sprinkler systems.

1.10 Approval Submittals:

1.10.1 Product Data: Submit manufacturer's technical product data and installation instructions for:

1.10.2 Pipe and fittings

1.10.3 Basic pipe supports and hangers

1.10.4 Basic valves

1.10.5 Special valves

1.10.6 Pressure gauges

1.10.7 Automatic sprinklers

1.10.8 Siamese connections

1.10.9 Cabinets

1.10.10 Working (Shop) Drawings: Prepare working (shop) drawings of fire protection systems indicating pipe sizes, pipe locations, pipe elevations, fittings, shutoffs, hangers, equipment, and coordination with other building systems. Submittal shall show all requirements per NFPA-13.

1.11 Test Reports and Verification Submittals:

1.11.1 Certificate: Submit certificate of Aboveground Installation upon completion of fire protection piping work which indicates that work has been tested in accordance with NFPA 13 and that system is operational, complete, and has no defects.

1.11.2 Tag: Submit a copy of the sprinkler system tag. The installing fire sprinkler contractor shall be licensed in accordance with State Fire Marshal (SFM) Rule 4A-46. At the conclusion of the project and prior to the final inspection by the SFM the Contractor shall tag the fire sprinkler system in accordance with 4A-46.041.

1.12 O&M Data Submittals:

1.12.1 Record Drawings: At project closeout, submit record drawings of installed fire protection

piping and products.

1.12.2 Maintenance Data: Submit a copy of all approval submittals. Submit maintenance data and parts lists for basic valves, special valves. Include these data in O&M manual.

1.12.3 NFPA 25: Provide a copy of NFPA 25 in each O&M Manual.

2 PRODUCTS

2.1 General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in fire protection systems. Where more than one type of material or products are indicated, selection is Installer's option.

2.2 Basic Identification: Provide identification complying with Division-23 Basic Mechanical Materials and Methods section "Mechanical Identification", in accordance with the following listing:

Fire Protection Piping: Plastic pipe markers. Fire piping exposed in mechanical and electrical rooms shall be painted red.

Fire Protection Valves: Plastic or brass valve tags

Fire Protection Signs: Provide the following signs:

At each sprinkler valve, sign indicating what portion of system valve controls and hydraulic design data.

At each outside alarm device, sign indicating what authority to call if device is activated.

At each auxiliary drain, a sign indicating location.

2.3 Basic Pipes and Pipe Fittings: Provide pipes and pipe fittings complying with Division-23 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings", in accordance with the following listing. Where multiple listings are made for a particular type system, the material is the Installer’s option.

2.4 Wet Pipe: Seamless ERW black steel pipe; Schedule 40 for less than 8"; Schedule 30 for 8" and larger. Fittings and joints shall be as follows.

1 Class 125, cast-iron threaded fittings with threaded joints.

2 Mechanical grooved pipe coupling and fittings; cut-groove type with mechanical joints.

3 Wrought steel buttwelding fittings with welded joints.

2.4.1 Fire Pump Suction: Seamless ERW galvanized steel pipe, Schedule 40.

1 Class 150 malleable iron galvanized threaded fittings.

2 Mechanical grooved pipe couplings and fittings; roll-groove or mechanical locking type with mechanical joints.

2.5 Basic Piping Specialties: Provide piping specialties complying with Division-23 Basic Mechanical Materials and Methods section "Piping Specialties".

2.6 Basic Supports and Anchors: Provide supports and anchors complying with Division-23 Basic Mechanical Materials and Methods section "Supports and Anchors", in accordance with the following listing:

Adjustable steel clevis hangers or adjustable steel band hangers for horizontal-piping hangers and supports.

Two-bolt riser clamps for vertical piping supports.

Steel turnbuckles and malleable iron sockets for hanger-rod attachments.

Concrete inserts, top-beam C-clamps, side beam or channel clamps or center beam clamps for building attachments.

2.7 Basic Valves: Provide interior valves complying with Division-23 Basic Mechanical Materials and Methods section "Valves", in accordance with the following listing:

2.7.1 Standard Service Code-Required OS&Y Valves: GA-6, GA-7.

2.7.2 Standard Service Sectional Valves: GA-6, GA-7. BF-6, BF-7.

2.7.3 Standard Service Indicating Valves: GA-6, GA-7, BA-6.

2.7.4 Standard Service Trim Valves: GA-6, BA-4.

2.7.5 Standard Service Check Valves: CK-4, CK-5.

2.8 Special Valves:

2.8.1 General: Provide valves, UL listed, in accordance with the following listing. Provide sizes and types which mate and match piping and equipment connections.

2.8.2 Alarm Check Valve: Provide cast-iron water flow alarm check valve, 175 psi working

pressure, with retard chamber.

2.8.3 Hose Outlet Valves: Provide angle hose valves, 2-1/2" size where not otherwise indicated. Provide chrome plated with escutcheons where mounted in cabinet. Provide chain and cap.

2.8.4 Ball Drip Check Valve: Provide fire department connection iron swing check valve, 175 psi rated working pressure, of size and end type indicated, with ball drip.

2.8.5 Acceptable Manufacturers: Subject to compliance with requirements, provide valves of one of the following:

Grinnell Fire Protection Systems Co., Inc.
Grunau Sprinkler Mfr. Co., Inc.
Reliable
Viking Corporation

2.9 Basic Meters and Gauges: Provide meters and gauges complying with Division-23 Basic Mechanical Materials and Methods section "Meters and Gauges", in accordance with the following listing:

2.9.1 Pressure gauges, 0-250 psi range.

2.10 Fire Protection Specialties: Provide fire protection specialties, UL listed, in accordance with the following listing. Provide sizes and types which mate and match piping and equipment connections.

2.10.1 Water Flow Indicators: Provide vane type water flow switches, with adjustable retard.

2.10.2 Electric Bell: Provide 10" weatherproof bell with red enameled finish, 90 db.

2.10.3 Supervisory Switches: Provide products recommended by manufacturer for use in service indicated.

2.10.4 Acceptable Manufacturers: Subject to compliance with requirements, provide fire protection specialties of one of the following:

Grinnell Fire Protection Systems Co., Inc.
Grunau Sprinkler Mfr. Co., Inc.
Guardian Fire Equipment, Inc.
Potter Roemer, Inc.
Reliable
Viking Corporation

2.11 Automatic Sprinklers: Provide automatic sprinklers and escutcheons of type indicated on drawings, and in accordance with the following listing. Provide quick response type

automatic sprinklers. Provide fusible links for 165°F unless otherwise indicated.

2.11.1 Sprinkler Types

Upright.
Pendent.
Recessed pendent.
Concealed pendent.
Horizontal sidewall.

2.11.2 Finish: White chrome-plated for recessed concealed heads in occupied areas. Chrome-plated for pendant heads in occupied areas. Cast brass for unoccupied areas.

2.11.3 Sprinkler Cabinet and Wrench: Furnish steel, baked red enameled, sprinkler box with capacity to store 10 sprinklers and wrench sized to sprinklers.

2.11.4 Acceptable Manufacturers: Subject to compliance with requirements, provide automatic sprinklers of one of the following:

Central Sprinkler Corp.
Grinnell Fire Protection Systems Co., Inc.
Star Sprinkler Mfg. Co. Inc.
Reliable
Viking Corp.

2.12 Siamese Connections:

2.12.1 Wall Type Siamese Connections: Provide wall type cast brass siamese connections and escutcheon plate assembly, with 2, 2-1/2" fire department inlets with female hose connections, fire hose connection screw thread (size and threads approved in writing by fire department), equipped with individual drop clapper valves, equipped with caps and chains, construction features as indicated, and constructed with the following additional construction features:

Finish: Chrome plate.

Inlet Pipe: As shown on the drawings.

Cast Lettering: "AUTO. SPKR. AND STANDPIPE."

Escutcheon: Rectangular.

Siamese Connection: Flush, adjacent inlets.

Basis of Design: Potter Roemer Figure 5020.

2.12.2 Acceptable Manufacturers: Subject to compliance with requirements, provide siamese connections of one of the following:

Allen (W.D.) Mfg. Div.
Croker-Standard
Elkhart Brass Mfg. Co., Inc.
Potter-Roemer Co.

3 EXECUTION

3.1 General: Examine areas and conditions under which fire protection materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer. Any installation, modification, or alteration of the sprinkler system shall be performed only by a person under a certificate of competency issued by the State Fire Marshal.

3.2 Installation of Basic Identification: Install mechanical identification in accordance with Division-23 Basic Mechanical Materials and Methods section "Mechanical Identification." Install fire protection signs on piping in accordance with NFPA 13 requirements. Continuously paint exposed fire piping red in mechanical and electrical rooms.

3.3 Installation of Pipes and Pipe Fittings:

3.3.1 General: Install pipes and pipe fittings in accordance with Division-23 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings."

3.3.2 Comply with requirements of NFPA 13 for installation of fire protection piping materials. Install piping products where indicated, in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that piping systems comply with requirements and serve intended purposes.

3.3.3 Coordinate with other work as necessary to interface components of fire protection piping properly with other work.

3.3.4 Install drain piping at low points of piping system. Provide dry drum drips where indicated.

3.3.5 Install hose outlet valves in piping where hose outlets are indicated.

3.3.6 Install sectional valves in inlet piping, at bottom of each riser, and in loops as indicated.

3.3.7 Install fire department connection valves in piping where fire department connections are indicated.

3.3.8 Install water flow indicators where indicated.

3.3.9 Mount supervisory switches on each sectional valve.

3.3.10 Install pressure gauges where required and at top of each standpipe.

3.3.11 Install valved hose connections of sizes indicated, or ¾" size if not otherwise indicated, on sprinkler at ends of branch lines and cross mains and at locations where indicated. The intent is to meet the requirements of NFPA 13 and to achieve a fully drainable system.

3.3.13 Install Inspector's test connection where indicated, or at most remote point from riser.

3.4 Installation of Piping Specialties: Install piping specialties in accordance with Division-23 Basic Mechanical Materials and Methods section "Piping Specialties."

3.5 Installation of Supports and Anchors: Install supports and anchors, in accordance with Division-23 Basic Mechanical Materials and Methods section, "Supports and Anchors."

3.6 Installation of Valves: Install valves in accordance with Division-23 Basic Materials and Methods section "Valves." Provide valves to isolate each riser and elsewhere as required by NFPA 13 .

3.7 Installation of Meters and Gauges: Install meters and gauges in accordance with Division-23 Basic Mechanical Materials and Methods section "Meters and Gauges."

3.8 Installation of Fire Protection Specialties: Install fire protection specialties as indicated, and in accordance with NFPA 13. Furnish wiring requirements to electrical Installer for electrical wiring of supervisory switches.

3.9 Field Quality Control:

3.9.1 Sprinkler Piping Flushing: Prior to connecting sprinkler risers for flushing, flush feed mains, lead-in connections and control portions of sprinkler piping. After fire sprinkler piping installation has been completed and before piping is placed in service, flush entire sprinkler system, as required to remove foreign substances, under pressure as specified in NFPA 13. Continue flushing until water is clear, and check to ensure that debris has not clogged sprinklers.

3.9.2 Hydrostatic Testing: After flushing system, test fire sprinkler piping hydrostatically, for period of 24 hours, at not less than 200 psi or at 50 psi in excess of maximum static pressure when maximum static pressure is in excess of 150 psi. Check system for leakage of joints. Measure hydrostatic pressure at low point of each system or zone being tested.

3.9.3 Repair or replace piping system as required to eliminate leakage in accordance with NFPA standards for "little or no leakage" and retest as specified to demonstrate compliance.

3.10 Cleaning and Inspecting: Clean and inspect fire protection systems in accordance with requirements of Division-23 Basic Mechanical Materials and Methods section "Testing, Cleaning, and Sterilization of Piping Systems".

3.11 Extra Stock:

3.11.1 Heads: For each style and temperature range required, furnish additional sprinkler heads, amounting to one unit for every 100 installed units, but not less than 5 units of each.

3.11.2 Wrenches: Furnish 2 spanner wrenches for each type and size of valve connection and fire hose coupling. Obtain receipt from Owner that extra stock has been received.

3.12 Owner Instruction: Provide technical services for one 4-hour period to instruct Owner's personnel in operation and maintenance of building sprinkler systems. Schedule training date with Owner. Provide at least 7-day notice to Engineer and Owner of training date.

END OF SECTION

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# SECTION 21 31 16 - DIESEL ENGINE DRIVE FIRE PUMP

1 GENERAL

1.1 Drawings and General provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-15 Basic Mechanical Requirements and Basic Mechanical Materials and Methods sections apply to work of this section.

1.3 Extent of fire pump work is indicated on drawings and schedules, and by requirements of this section.

1.4 Refer to other Division-15 sections for exhaust insulation and for fire protection piping and fuel oil piping and appurtenances not specified herein; not work of this section.

1.5 Refer to Division-3, "Concrete" for pump bases; included as work of this section.

1.6 Refer to Division-9 "Painting" for painting of all piping and devices; not work of this section. All exposed piping in fire pump rooms shall be painted red.

1.7 Refer to Division-16 sections for the following work; not work of this section.

1.7.1 Power supply wiring from power source to power connection on pumps, engines, and controllers. Include disconnects and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

1.7.2 Interlock wiring between engines, pumps and between controllers and field-installed control devices.

1.7.3 Fire alarm connections from fire pump controllers.

1.8 Codes and Standards:

1.8.1 NFPA Compliance: Install fire pumps in accordance with NFPA 20 "Standard for the Installation of Centrifugal Fire Pumps."

1.8.2 UL Compliance: Provide listed fire pumps and products in accordance with UL standards; provide UL label on each product.

1.8.3 FM Compliance: Provide fire pumps, products and installations in accordance with FM standards; provide FM label on each product.

1.8.4 Fire Department/Fire Marshal Compliance: Install fire pumps in accordance with local regulations of fire department or fire marshal.

1.8.5 Screw Thread Connections: Comply with local Fire Department/Fire Marshal regulations for sizes, threading and arrangement of connections for fire department equipment to fire protection systems.

1.8.6 National Electric Code: Provide fire pumps, controllers, and products complying with the National Electric Code, NFPA-70.

1.9 Approval Submittals:

1.9.1 Product Data: Submit manufacturer's technical product data, specifications, installation and start-up instructions, and pump characteristic performance curves with selection points clearly indicated. Submit manufacturer's assembly-type drawings for each product indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

1.9.1.1 Fire pump

1.9.1.2 Fire pump engine

1.9.1.3 Fire pump engine controller

1.9.1.4 Fuel oil tank

1.9.1.5 Batteries and rack

1.9.1.6 Engine cooling system

1.9.1.7 Muffler

1.9.1.8 Exhaust flexible connector

1.9.1.9 Accessories

1.9.1.10 Jockey pump

1.9.1.11 Jockey pump controller

1.10 Test Reports and Verification Submittals:

1.10.1 Certified Test Report: Submit certified factory test results from hydrostatic test and performance tests (capacity, head, efficiency, and brake horsepower). Submit certified results of battery cranking cycle capability. All tests shall be performed in accordance with NFPA-20.

1.10.2 Pump Acceptance Test Report: Submit fire pump acceptance test report per NFPA-20.

1.10.3 Controller Acceptance Test Report: Submit fire pump controller acceptance test report per NFPA-20.

1.11 O&M Data Submittals:

1.11.1 Maintenance Data: Submit a copy of all approval submittals. Submit maintenance data and parts lists for each type of pump, engine, controller, batteries, and remote panels, including "trouble-shooting" maintenance guide. Include these data and wiring diagrams in O&M Manual; in accordance with requirements of Division 1.

1.11.2 Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to engines, pumps and controllers. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed. Include in O&M Manual.

2 PRODUCTS

2.1 General: Provide factory-tested pumps, engines, controllers, and related equipment, thoroughly cleaned, and painted prior to shipment. Type, size and capacity of each pump is listed in the schedule or on the drawings.

2.2 Acceptable Manufacturers: Subject to compliance with requirements, provide pumps and controllers of one of the following:

ITT-AC Pump
Aurora
Patterson
Peerless

2.3 Unit Purchase: Pump, engine, jockey pump, controller, and related equipment shall be purchased under a unit contract stipulating compliance with NFPA-20. The pump manufacturer shall be responsible for proper operation of the complete assembly as indicated by field acceptance tests.

2.4 Fire Pump: Provide UL-listed, diesel drive, horizontal split case fire pumps with the following performance and features:

2.4.1 Performance: The pump shall deliver at least 150% of rated capacity at 65% of rated head. The shutoff pressure shall not exceed 120% of rated pressure.

2.4.2 Type: Provide base-mounted, double-suction, bronze-fitted, single stage, centrifugal pump. Provide nameplate.

2.4.3 Drive: Provide diesel engine drive per NFPA-20. Provide flexible coupling, coupling guard, splash guard, and nameplate.

2.4.4 Mounting: Provide common base plate with machined registered fits for alignment.

2.4.5 Casing: Provide split casings with removable upper half to allow rotating element to be removed without disconnecting flanges.

2.4.6 Impellers: Provide cast bronze, enclosed type impellers, dynamically balanced and keyed to shaft.

2.4.7 Shaft: Provide steel shaft with replaceable shaft sleeve.

2.4.8 Casing Rings: Provide renewable casing wear rings designed so that pressure will seat them to the casing.

2.5 Fire Pump Accessories: Provide the following accessories:

2.5.1 Suction and discharge pressure gauges, 3-1/2" diameter, compound for suction duty.

2.5.2 Automatic circulation relief valve set less than shut off pressure and provisions for discharge to drain, ¾" size to 2500 gpm.

2.5.3 Relief valve and cone. Size per NFPA-20.

2.5.4 Eccentric tapered suction reducer.

2.5.5 Concentric tapered discharge increaser.

2.5.6 Float-operated auto air release for split case pumps.

2.5.7 Hose valves, caps, and chains, 2-1/2".

2.5.8 Hose valve test manifold with piping connections rated at gpm.

2.5.9 Flow measuring device to gpm.

2.5.10 Discharge tees.

2.6 Diesel Engine Drive: Provide UL-listed, factory mounted diesel engine drives complying with NFPA-20, with the following features:

2.6.1 Provide governor to regulate engine speed within 10% of rated speed from shutoff to maximum load. Provide device to field adjust, set, and secure the setting.

2.6.2 Provide overspeed device to automatically shutdown the engine at 120% of rated speed. Provide manual reset. Provide supervised trouble signal that remains on until the engine is reset.

2.6.3 Instrument Panel: Provide tachometer (rpm and totalizing), oil pressure gauge and temperature gauge for cooling water.

2.6.4 Provide main battery contactors capable of automatic or manual mechanical operation.

2.6.5 Provide for electric starting with two storage batteries and racks. Each battery shall be capable of cranking the engine through the cycle required by NFPA-20.

2.6.6 Provide for automatic battery recharging via engine alternator or generator and a separate AC power supply. The charger shall include rectifier, ammeter, and control panel.

2.6.7 Engine Cooling: Provide a closed circuit cooling system that is cooled by using water from the fire pump discharge. Provide engine driven circulating pump, heat exchanger, temperature regulating valve, pressure regulator, and all required valves, strainers, gauges, and fittings.

2.6.8 Fuel Oil System: Provide above ground fuel oil tank, size as shown on the drawings, with fill, drain and vent connections. Provide flame resistant flexible hoses, filters and other devices as required to make connections to the engine fuel oil pump.

2.6.9 Engine Exhaust: Provide corrugated flexible exhaust connector and muffler.

2.7 Engine Drive Controller: Provide factory-wired and tested, UL-listed engine drive controller, per NFPA-20, with the following features:

2.7.1 Provide grounded controllers with locked cabinets marked "DIESEL ENGINE FIRE PUMP CONTROLLER".

2.7.2 Provide voltage surge protection devices.

2.7.3 Provide local alarm and signal devices with separate visible alarms and common audible alarms. Provide alarms for:

Automatic position indicator (not in automatic)
Low oil pressure
High engine jacket temperature
Failure of engine to start automatically
Overspeed shutdown
Battery failure - each battery
Battery charger failure

2.7.4 Provide separate remote alarm and signal devices to fire alarm control panel (by Division-16) as follows:

Engine running.
Controller in off or manual.
Trouble on engine or controller.

2.7.5 Provide 7 day pressure recorder.

2.7.6 Automatic Control: Provide water pressure controller for automatic start. Provide weekly program timer with solenoid valve in pressure sensing line to automatically run the engine for 30 minutes once a week.

2.7.7 Nonautomatic Control: Provide manual electric switch on the controller to start engine regardless of water pressure.

2.7.8 Starting: Provide for starting engine from either battery unit. Changeover batteries automatically on successive starts. Provide alarm on failure to start after 6 crank periods. If one battery fails, lock in the operating battery for all starts.

2.7.9 Stopping: Provide for manual electric shutdown by a switch on the controller. Automatic shutdown shall occur by weekly timer, overspeed, or high temperature/low oil pressure if no other starting cause exists during engine test.

2.7.10 Provide startup service.

2.8 Jockey Pump and Accessories: Provide the following:

2.8.1 Centrifugal jockey pump and motor.

2.8.2 Relief valve.

2.8.3 Factory-wired and tested, UL-listed controller with HOA switch, fused disconnect switch, thermal overloads, external reset, magnetic starter, pressure controller, and running time indicator.

3 EXECUTION

3.1 General: Examine areas and conditions under which fire pump materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 Installation of Basic Identification: Install mechanical identification in accordance with Division-15 Basic Mechanical Materials and Methods section "Mechanical Identification".

3.3 Installation of Pipes and Pipe Fittings:

3.3.1 General: Install pipes and pipe fittings in accordance with Division-15 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings".

3.3.2 Comply with requirements of NFPA-13 for installation of fire protection piping materials. Install piping products where indicated, in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that piping systems comply with requirements and serve intended purposes.

3.3.3 Install OS&Y valve in the fire pump suction as far from the pump as possible. Do not install ells within 5 pipe diameters of the pump suction and not in the plane parallel to the pump shaft. Sleeve all pipes through the wall or floor with proper clearance.

3.3.4 Install OS&Y valve and listed check valve in fire pump discharge. Provide anti-water hammer check valve where indicated.

3.3.5 Above grade suction piping shall be galvanized steel.

3.3.6 Install hose valve test manifold with OS&Y valve, listed check valve and ball drip.

3.4 Installation of Piping Specialties: Install piping specialties in accordance with Division-15 Basic Mechanical Materials and Methods section "Piping Specialties".

3.5 Installation of Supports and Anchors: Install supports and anchors, in accordance with Division-15 Basic Mechanical Materials and Methods section, "Support and Anchors".

3.6 Installation of Valves: Install valves in accordance with Division-15 Basic Materials and Methods section "Valves".

3.7 Installation of Meters and Gauges: Install meters and gauges in accordance with Division-15 Basic Mechanical Materials and Methods section "Meters and Gauges".

3.8 Install fire pump and engine in accordance with manufacturer's written instructions. Provide reinforced concrete pad, set and level unit, and align unit. Tighten bolts after piping has been connected and grout has set. Installation and alignment shall be performed under the supervision of a factory-trained representative.

3.9 Install jockey pump in accordance with the manufacturer's written instructions. Provide

concrete pad, gate valves, and discharge check valve.

3.10 Install controllers in accordance with the manufacturer's written instructions. Locate engine drive controller and jockey pump controller as close as practical, and within sight of the fire pump and jockey pump respectively. Maintain code clearances. Protect controllers from water spray.

3.11 Furnish electrical wiring diagrams and requirements to electrical installer. All electrical work shall be in accordance with the NEC and NFPA-20.

3.12 Cleaning and Inspecting: Clean and inspect fire protection system in accordance with requirements of Division-15 Basic Mechanical Materials and Methods section "Testing, Cleaning and Sterilization of Piping Systems".

3.13 Field Quality Control:

3.13.1 Test suction piping per NFPA-24 and discharge piping per NFPA-13.

3.13.2 Hydrostatic Testing: After flushing system, test fire sprinkler piping hydrostatically, for period of 24 hours, at not less than 200 psi or at 50 psi in excess of maximum static pressure when maximum static pressure is in excess of 150 psi. Check system for leakage of joints.

3.13.3 Repair or replace piping system as required to eliminate leakage in accordance with NFPA standards for "little or no leakage" and retest as specified to demonstrate compliance.

3.14 Pump Acceptance Tests: Perform pump flow tests in presence of manufacturer's representative, contractor, Engineer, fire department representative, and Owner. Provide all test equipment and perform tests per NFPA-20. Provide pump acceptance test report.

3.15 Controller Acceptance Tests: Perform controller tests in presence of manufacturer's representative, contractor, Engineer, fire department representative, and Owner. Provide all test equipment and perform tests per NFPA-20. Perform at least 10 automatic and 10 manual operations, each of at least 5 minutes duration. Test both sets of batteries. Tests shall result in at least one hour of pump run time. Provide controller acceptance test report.

3.16 Jockey Pump: Set to maintain 10 psi above fire pump setting.

END OF SECTION

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# SECTION 22 01 00 - PLUMBING GENERAL

1 GENERAL

1.1 The work covered by this division consists of providing all labor, equipment and materials and performing all operations necessary for the installation of the plumbing work as herein called for and shown on the drawings.

1.2 Related Documents:

1.2.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2.2 This is a Basic Plumbing Requirements Section. Provisions of this section apply to work of all Division 22 sections. Provisions of Division 23 Basic Mechanical Requirements apply to work of all Division 22 sections.

1.2.3 Review all other contract documents to be aware of conditions affecting work herein.

1.2.4 Definitions:

1.2.4.1 Provide: Furnish and install, complete and ready for intended use.

1.2.4.2 Furnish: Supply and deliver to project site, ready for subsequent requirements.

1.2.4.3 Install: Operations at project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar requirements.

1.3 Permits and Fees: Contractor shall obtain all necessary permits, meters, and inspections required for his work and pay all fees and charges incidental thereto.

1.4 Verification of Owner's Data: Prior to commencing any work the Contractor shall satisfy himself as to the accuracy of all data as indicated in these plans and specifications and/or as provided by the Owner. Should the Contractor discover any inaccuracies, errors, or omissions in the data, he shall immediately notify the Architect/Engineer in order that proper adjustments can be anticipated and ordered. Commencement by the Contractor of any work shall be held as an acceptance of the data by him after which time the Contractor has no claim against the Owner resulting from alleged errors, omissions or inaccuracies of the said data.

1.5 Delivery and Storage of Materials: Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. All material shall be stored to provide protection from the weather and accidental damage.

1.6 Extent of work is indicated by the drawings, schedules, and the requirements of the specifications. Singular references shall not be constructed as requiring only one device if multiple devices are shown on the drawings or are required for proper system operation.

1.7 Field Measurements and Coordination:

1.7.1 The intent of the drawings and specifications is to obtain a complete and satisfactory installation. Separate divisional drawings and specifications shall not relieve the Contractor or subcontractors from full compliance of work of his trade indicated on any of the drawings or in any section of the specifications.

1.7.2 Verify all field dimensions and locations of equipment to insure close, neat fit with other trades' work. Make use of all contract documents and approved shop drawings to verify exact dimension and locations.

1.7.3 Coordinate work in this division with all other trades in proper sequence to insure that the total work is completed within contract time schedule and with a minimum cutting and patching.

1.7.4 Locate all apparatus symmetrical with architectural elements. Install to exact height and locations when shown on architectural drawings. When locations are shown only on plumbing drawings, be guided by architectural details and conditions existing at job and correlate this work with that of others.

1.7.5 Install work as required to fit structure, avoid obstructions, and retain clearance, headroom, openings and passageways. Cut no structural members without written approval.

1.7.6 Carefully examine any existing conditions, piping, and premises. Compare drawings with existing conditions. Report any observed discrepancies. It shall be the Contractor's responsibility to properly coordinate the work and to identify problems in a timely manner. Written instructions will be issued to resolve discrepancies.

1.7.7 Because of the small scale of the drawings, it is not possible to indicate all offsets and fittings or to locate every accessory. Drawings are essentially diagrammatic. Study carefully the sizes and locations of structural members, wall and partition locations, trusses, and room dimensions and take actual measurements on the job. Locate piping, ductwork, equipment and accessories with sufficient space for installing and servicing. Contractor is responsible for accuracy of his measurements and for coordination with all trades. Contractor shall not order materials or perform work without such verification. No extra compensation will be allowed because field measurements vary from the dimensions on the drawings. If field measurements show that equipment or piping cannot be fitted, the Architect/Engineer shall be consulted. Remove and relocate, without additional compensation, any item that is installed and is later found to encroach on space assigned to another use.

1.8 Guarantee:

1.8.1 The Contractor shall guarantee labor, materials and equipment for a period of one (1) year from Final Completion, or from Owner's occupancy, whichever is earlier. Contractor shall make good any defects and shall include all necessary adjustments to and replacement of defective items without expense to the Owner.

1.8.2 Owner reserves right to make emergency repairs as required to keep equipment in operation without voiding Contractor's Guarantee Bond nor relieving Contractor of his responsibilities during guarantee period.

1.9 Approval Submittals:

1.9.1 When approved, the submittal control log and submittals shall be an addition to the specifications herewith, and shall be of equal force in that no deviation will be permitted except with the approval of the Architect/Engineer.

1.9.1.1 Shop drawings, product literature, and other approval submittals will only be reviewed if they are submitted in full accordance with the General and Supplementary Conditions and Division 1 Specification sections and the following.

1.9.1.1.1 Submittals shall be properly organized in accordance with the approved submittal control log.

1.9.1.1.2 Submittals shall not include items from more than one specification section in the same submittal package unless approved in the submittal control log.

1.9.1.1.3 Submittals shall be properly identified by a cover sheet showing the project name, Architect and Engineer names, submittal control number, specification section, a list of products or item names with model numbers in the order they appear in the package, and spaces for approval stamps. A sample cover sheet is included at the end of this section.

1.9.1.1.4 Submittals shall have been reviewed and approved by the General Contractor (or Prime Contractor). Evidence of this review and approval shall be an "Approved" stamp with a signature and date on the cover sheet.

1.9.1.1.5 Submittals that include a series of fixtures or devices (such as plumbing fixtures or valves) shall be organized by the fixture number or valve type and be marked accordingly. Each fixture must include all items associated with that fixture regardless of whether or not those items are used on other fixtures.

1.9.1.1.6 The electrical design shown on the drawings supports the plumbing equipment basis of design specifications at the time of design. If plumbing equipment is submitted with different electrical requirements, it is the responsibility of the plumbing contractor to resolve all required electrical design changes (wire and conduit size, type of disconnect or overload protection, point(s) of connection, etc.) and clearly show the new electrical design on the plumbing submittal with a written statement that this change will be provided at no additional cost. Plumbing submittals made with no written reference to the electrical design will be presumed to work with the electrical design. Any corrections required will be at no additional cost.

1.9.2 If the shop drawings show variation from the requirements of contract because of standard shop practice or other reasons, the Contractor shall make specific mention of such variation in writing in his letter of transmittal and on the submittal cover sheet in order that, if acceptable, Contractor will not be relieved of the responsibility for executing the work in accordance with the contract.

1.9.3 Review of shop drawings, product literature, catalog data, or schedules shall not relieve the Contractor from responsibility for deviations from contract drawings or specifications, unless he has in writing called to the attention of the Architect/Engineer each such deviation in writing at the time of submission, nor shall it relieve him from responsibility for errors of any sort in shop drawings, product literature, catalog data, or schedules. Any feature or function specified but not mentioned in the submittal shall be assumed to be included per the specification.

1.9.4 Submit shop drawings as called for in other sections after award of the contract and before any material is ordered or fabricated. Shop drawings shall consist of plans, sections, elevations and details to scale (not smaller than ¼" per foot), with dimensions clearly showing the installation. Direct copies of small scale project drawings issued to the Contractor are not acceptable. Drawings shall take into account equipment furnished under other sections and shall show space allotted for it. Include construction details and materials.

1.10 Test Reports and Verification Submittals: Submit test reports, certifications and verification letters as called for in other sections. Contractor shall coordinate the required testing and documentation of system performance such that sufficient time exists to prepare the reports, submit the reports, review the reports and take corrective action within the scheduled contract time.

1.11 O&M Data Submittals: Submit Operation and Maintenance data as called for in other sections. When a copy of approval submittals is included in the O&M Manual, only the final "Approved" or "Approved as Noted" copy shall be used. Contractor shall organize these data in the O&M Manuals tabbed by specification number. Prepare O&M Manuals as required by Division 1 and as described herein.. Submit manuals at the Substantial Completion inspection.

2 PRODUCTS

2.1 All materials shall be new or Owner-supplied reused as shown on the drawings, the best of their respective kinds, suitable for the conditions and duties imposed on them at the building and shall be of reputable manufacturers. The description, characteristics, and requirements of materials to be used shall be in accordance with qualifying conditions established in the following sections.

2.2 Equipment and Materials:

2.2.1 Shall be new and the most suitable grade for the purpose intended. Equipment furnished under this division shall be the product of a manufacturer regularly engaged in the manufacture of such items for a period of three years. Where practical, all of the components shall be products of a single manufacturer in order to provide proper coordination and responsibility. Where required, Contractor shall furnish proof of installation of similar units or equipment.

2.2.2 Each item of equipment shall bear a name plate showing the manufacturer's name, trade name, model number, serial number, ratings and other information necessary to fully identify it. This plate shall be permanently mounted in a prominent location and shall not be concealed, insulated or painted.

2.2.3 The label of the approving agency, such as UL, IBR, ASME, ARI, AMCA, by which a standard has been established for the particular item shall be in full view.

2.2.4 The equipment shall be essentially the standard product of a manufacturer regularly engaged in the production of such equipment and shall be a product of the manufacturer's latest design.

2.2.5 A service organization with personnel and spare parts shall be available within two hours for each type of equipment furnished.

2.2.6 Install in accordance with manufacturer's recommendations. Place in service by a factory trained representative where required.

2.2.7 Materials and equipment are specified herein by a single or by multiple manufacturers to indicate quality, material and type of construction desired. Manufacturer's products shown on the drawings have been used as basis for design; it shall be the Contractor's responsibility to ascertain that alternate manufacturer's products, or the particular products of named manufacturers, meet the detailed specifications and that size and arrangement of equipment are suitable for installation.

2.2.8 Model Numbers: Catalog numbers and model numbers indicated in the drawings and specifications are used as a guide in the selection of the equipment and are only listed for the contractor's convenience. The contractor shall determine the actual model numbers for ordering materials in accordance with the written description of each item and with the intent of the drawings and specifications.

2.3 Requests for Substitution:

2.3.1 Where a particular system, product or material is specified by name, consider it as standard basis for bidding, and base proposal on the particular system, product or material specified.

2.3.2 Requests by Contractor for substitution will be considered only when reasonable, timely, fully documented, and qualifying under one or more of the following circumstances.

2.3.2.1 Required product cannot be supplied in time for compliance with Contract time requirements.

2.3.2.2 Required product is not acceptable to governing authority, or determined to be non-compatible, or cannot be properly coordinated, warranted or insured, or has other recognized disability as certified by Contractor.

2.3.2.3 Substantial cost advantage is offered Owner after deducting offsetting disadvantages including delays, additional compensation for redesign, investigation, evaluation and other necessary services and similar considerations.

2.3.3 All requests for substitution shall contain a "Comparison Schedule" and clearly and specifically indicate any and all differences or omissions between the product specified as the basis of design and the product proposed for substitution. Differences shall include but shall not be limited to data as follows for both the specified and substituted products:

Principal of operation.
Materials of construction or finishes.
Thickness of gauge of materials.
Weight of item.
Deleted features or items.
Added features or items.
Changes in other work caused by the substitution.
Performance curves.

If the approved substitution contains differences or omissions not specifically called to the attention of the Architect/Engineer, the Owner reserves the right to require equal or similar

features to be added to the substituted products (or to have the substituted products replaced) at the Contractor's expense.

3 EXECUTION

3.1 Workmanship: All materials and equipment shall be installed and completed in a first-class workmanlike manner and in accordance with the best modern methods and practice. Any materials installed which do not present an orderly and reasonably neat and/or workmanlike appearance, or do not allow adequate space for maintenance, shall be removed and replaced when so directed by the Architect/Engineer.

3.2 Coordination:

3.2.1 The Contractor shall be responsible for full coordination of the plumbing systems with shop drawings of the building construction so the proper openings and sleeves or supports are provided for piping, ductwork, or other equipment passing through slabs or walls.

3.2.2 Any additional steel supports required for the installation of any plumbing equipment, piping, or ductwork shall be furnished and installed under the section of the specifications requiring the additional supports.

3.2.3 It shall be the Contractor's responsibility to see that all equipment such as valves, dampers, filters and such other apparatus or equipment that may require maintenance and operation are made easily accessible, regardless of the diagrammatic location shown on the drawings.

3.2.4 All connections to fixtures and equipment shown on the drawings shall be considered diagrammatic unless otherwise indicated by detail. The actual connections shall be made to fully suit the requirements of each case and adequately provide for expansion and servicing.

3.2.5 The contractor shall protect equipment, material, and fixtures at all times. He shall replace all equipment, material, and fixtures which are damaged as a result of inadequate protection.

3.2.6 Prior to starting and during progress of work, examine work and materials installed by others as they apply to work in this division. Report conditions which will prevent satisfactory installation.

3.2.7 Start of work will be construed as acceptance of suitability of work of others.

3.3 Interruption of Service: Before any equipment is shut down for disconnecting or tie-ins, arrangements shall be made with the Architect/Engineer and this work shall be done at the time best suited to the Owner. This will typically be on weekends and/or holidays and/or after normal working hours. Services shall be restored the same day unless prior arrangements are made. All overtime or premium costs associated with this work shall be included in the base bid.

3.4 Phasing: Provide all required temporary valves, piping, ductwork, equipment and devices as required. Maintain temporary services to areas as required. Remove all temporary material and equipment on completion of work unless Engineer concurs that such material and equipment would be beneficial to the Owner on a permanent basis.

3.5 Cutting and Patching: Notify General Contractor to do all cutting and patching of all holes, chases, sleeves, and other openings required for installation of equipment furnished and installed under this section. Utilize experienced trades for cutting and patching. Obtain permission from Architect/Engineer before cutting any structural items.

3.6 Equipment Setting: Bolt equipment directly to concrete pads or vibration isolators as required, using hot-dipped galvanized anchor bolts, nuts and washers. Level equipment.

3.7 Painting: Touch-up factory finishes on equipment located inside and outside shall be done under Division 22. Obtain matched color coatings from the manufacturer and apply as directed. If corrosion is found during inspection on the surface of any equipment, clean, prime, and paint, as required.

3.8 Clean-up: Thoroughly clean all exposed parts of apparatus and equipment of cement, plaster, and other materials and remove all oil and grease spots. Repaint or touch up as required to look like new. During progress of work, contractor is to carefully clean up and leave premises and all portions of building free from debris and in a clean and safe condition.

3.9 Start-up and Operational Test: Start each item of equipment in strict accordance with the manufacturer's instructions; or where noted under equipment specification, start-up shall be done by a qualified representative of the manufacturer. Alignment, lubrication, safety, and operating control shall be included in start-up check.

3.10 Record Drawings:

3.10.1 During the progress of the work the Contractor shall record on their field set of drawings the exact location, as installed, of all piping, ductwork, equipment, and other systems which are not installed exactly as shown on the contract drawings.

3.10.2 Upon completion of the work, record drawings shall be prepared as described in the General Conditions, Supplementary Conditions, and Division 1 sections.

3.11 Acceptance:

3.11.1 Punch List: Submit written confirmation that all punch lists have been checked and the required work completed.

3.11.2 Instructions: At completion of the work, provide a competent and experienced person who is thoroughly familiar with project, for one day to instruct permanent operating personnel in operation of equipment and control systems. This is in addition to any specific equipment operation and maintenance training.

3.11.3 Operation and Maintenance Manuals: Furnish four complete manuals bound in ring binders with Table of Contents, organized, and tabbed by specification section. Manuals shall contain:

Detailed operating instructions and instructions for making minor adjustments.
Complete wiring and control diagrams.
Routine maintenance operations.

Manufacturer's catalog data, service instructions, and parts lists for each piece of operating equipment.
Copies of approved submittals.
Copies of all manufacturer's warranties.
Copies of test reports and verification submittals.

3.11.4 Record Drawings: Submit record drawings.

**END OF SECTION 22 01 00**

# SECTION 22 07 00 - INSULATION FOR PLUMBING EQUIPMENT AND PIPING

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-22 Basic Plumbing Materials and Methods Sections apply to work of this section.

1.3 Division-23 Basic Mechanical Materials and Methods Sections apply to work of this section.

1.4 Approval Submittals:

1.4.1 Product Data: Submit a producer's data sheets and installation instructions on each insulation system including insulation, coverings, adhesives, sealers, protective finishes, and other material recommended by the manufacturer for applications indicated. Submit for:

Fiberglass pipe insulation
Cellular glass pipe below ground insulation
Flexible unicellular piping insulation

1.5 O&M Data Submittals: Submit a copy of all approval submittals. Include in O&M Manual.

2 PRODUCTS

2.1 Acceptable Manufacturers: Subject to compliance with requirements, provide insulation products by Armstrong, Johns Manville, Knauf, Owens Corning, Pittsburgh Corning, U.S. Rubber, or approved equal. All products shall be asbestos-free.

2.2 Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics, and adhesive) with a flame-spread rating of 25 or less, and a smoke-developed rating of 50 or less, as tested by ANSI/ASTM E84.

2.3 Pipe Insulation Materials:

2.3.1 Fiberglass Pipe Insulation: ASTM C547, Class 1 unless otherwise indicated. (Preformed sleeving with white all-service jacket, suitable for temperatures up to 450°F)

2.3.2 Cellular Glass Pipe Insulation: ASTM C552, Type II, Class 1. (Uncovered.)

2.3.3 Flexible Unicellular Pipe Insulation: ASTM C534, Type I. (Tubular, suitable for use to 200ºF.)

2.3.4 Staples, Bands, Wires, and Cement: As recommended by the insulation manufacturer for applications indicated.

2.3.5 Adhesives, Sealers, Protective Finishes: Products recommended by the insulation manufacturer for the application indicated.

2.3.6 Jackets: ASTM C921, Type I (vapor barrier) for piping below ambient temperature, Type II (vapor permeable) for piping above ambient temperature. Type I may be used for all piping at Installer's option.

3 EXECUTION

3.1 General:

3.1.1 Install thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

3.1.2 Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

3.1.3 Maintain integrity of vapor-barrier on insulation and protect it to prevent puncture and other damage. Label all insulation "ASBESTOS FREE".

3.1.4 Do not apply insulation to surfaces while they are hot or wet.

3.1.5 Do not install insulation until systems have been checked and found free of leaks. Surfaces shall be clean and dry before attempting to apply insulation. A professional insulator with adequate experience and ability shall install insulation.

3.1.6 Do not install insulation on pipe systems until acceptance tests have been completed except for flexible unicellular insulation. Do not install insulation until the building is "dried-in".

3.2 Fiberglass Pipe Insulation:

3.2.1 Insulate the following piping systems (indoor locations):

3.2.1.1 Domestic hot water, 141º-180° F: up to 1-1/4" pipe - 1½" thick, over 1-1/4" pipe 2" thick.

3.2.1.2 Domestic hot water and hot water return, 105º-140° F: up to 3" pipe - 1½" thick, over 3" pipe - 2" thick.

3.2.2 Apply insulation to pipe with all side and end joints butted tightly. Seal longitudinal lap by pressurizing with plastic sealing tool. Apply 3 inch wide self sealing butt strips to joints between insulation sections. Insulate all fittings, flanges, valves and strainers with premolded insulation. Apply coat of insulating cement to fittings and wrap with glass cloth overlapping each wrap 1" and adjacent pipe 2". Finish with heavy coat of general purpose mastic. Premolded PVC covers may also be used, but no flexible inserts are allowed.

3.2.3 Provide hanger or pipe support shields of 16 gauge (minimum) galvanized steel over the insulation which extends halfway up the pipe insulation cover and at least 6" on each side of the hanger.

3.2.4 Omit insulation on exposed plumbing fixture runouts from faces of wall or floor to fixture; on unions, flanges, strainer blowoffs, flexible connections and expansion joints.

3.3 Cellular Glass Pipe Insulation (Underground):

3.3.1 Insulate the following piping systems:

3.3.1.1 Domestic hot water: smaller than 6" pipe -1½" thick, 6" and larger pipe -2" thick.

3.3.2 Cut insulation in sections at fittings and carefully fit to the pipe and fittings. No stovepipe or single miter insulation is allowed. Apply vapor barrier mastic to all edges of the cellular insulation and between joints in the insulation. Wire the cellular glass in place with stainless steel wire 9 inches on center. Finish with a prefabricated water barrier self-sealing jacket similar to Pittsburg Corning “Pittwrap SSII”, 70 mils thickness. Insulate all anchors, guides, wall penetrations, expansion joints, loops and ells in accordance with the manufacturer's recommendations. Use rubber spacers at all expansion fittings.

3.4 Flexible Unicellular Pipe Insulation:

3.4.1 Insulate the following piping systems:

3.4.1.1 Horizontal above-grade waste piping receiving condensate from air conditioning units to points of connection receiving waste from 4 or more fixtures - ½" thick.

3.4.1.2 Horizontal above grade waste piping receiving discharge from ice machines, coolers, freezers or similar units to points of connection receiving waste form 4 or more fixtures - ½" thick.

3.4.1.3 Floor drain bodies located above ceiling or above grade and receiving condensate from air conditioning units.

3.4.1.4 Air compressor after-cooler piping - ¾" thick.

3.4.2 Apply insulation in accordance with the manufacturer's recommendations and instructions. Mitre cut insulation to fit pipe fittings. Use approved cement to seal all joints and ends in the insulation.

**END OF SECTION 22 07 00**

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# SECTION 22 11 13 - POTABLE WATER SYSTEM

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-22 Basic Plumbing Requirements and Basic Plumbing Materials and Methods sections apply to work of this section.

1.3 Division-23 Basic Mechanical Materials and Methods Sections apply to work of this section.

1.4 Extent of potable water systems work, is indicated on drawings and schedules, and by requirements of this section.

1.5 Refer to appropriate Division-2 sections for exterior potable water system; not work of this section unless noted.

1.6 Insulation for potable water piping is specified in other Division-22 sections, and is included as work of this section. Insulation requirements include:

1.6.1 Domestic hot water piping

1.7 Excavation and backfill required in conjunction with water piping is specified in other Division-23 sections, and is included as work of this section.

1.8 Code Compliance: Comply with applicable portions of Florida Building Code-Plumbing pertaining to selection and installation of plumbing materials and products. Comply with local utility requirements.

1.9 Approval Submittals:

1.9.1 Product Data: Submit manufacturer's technical product data and installation instructions for:

Valves
Strainers
Hose bibbs
Wall hydrants
Water hammer arresters
Relief valves
Trap primers
Access doors

1.10 Test Reports and Verification Submittals:

1.10.1 Disinfection: Submit report by Health Department.

1.11 O&M Data Submittals: Submit a copy of all approval submittals. Submit maintenance data and parts lists for valves, trap primers. Include these data in O&M manual.

2 PRODUCTS

2.1 General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with Florida Building Code-Plumbing where applicable. Provide sizes and types matching pipe materials used in potable water systems. Where more than one type of materials or products is indicated, selection is Installer's option.

2.2 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following listed for each item.

2.3 Identification: Provide identification complying with Division-23 Basic Mechanical Materials and Methods section "Mechanical Identification". Provide manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct burial service; not less than 6" wide x 4 mils thick. Provide blue tape with black printing reading "CAUTION WATER LINE BURIED BELOW".

2.4 Pipes and Fittings: Provide pipes and pipe fittings complying with Division-23 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings", in accordance with the following listing:

2.4.1 Interior Water Piping:

2.4.1.1 Above Grade: Copper tube; Type L, hard-drawn temper; wrought-copper fittings, solder-joints.

2.4.1.2 Below Grade: Copper tube; Type L, soft-annealed temper; no joints below floor.

2.4.2 Exterior Water Piping:

2.4.2.1 Copper tube; Type L, hard-drawn temper; wrought-copper fittings, solder-joints.

2.4.3 Solder joints shall be made with 95-5 solder.

2.5 Piping Specialties: Provide piping specialties complying with Division-23 Basic Mechanical Materials and Methods section "Piping Specialties".

2.6 Supports and Anchors: Provide supports and anchors complying with Division-23 Basic Mechanical Materials and Methods section "Supports and Anchors".

2.7 Interior Valves: Provide valves complying with Division-23 Basic Mechanical Materials and Methods section "Valves", in accordance with the following listing:

2.7.1 Sectional and Shutoff Valves: GA1, GA2, GA3, BA1, BA2.

2.7.2 Drain Valves: GA1, GA2, BA1, BA2.

2.7.3 Throttling Valves: GL1, GL2, BA1, BA2.

2.7.4 Check Valves: CK1, CK2, CK3.

2.8 Exterior Valves: Provide as indicated, gate valves, AWWA C500, 175 psi working

pressure. Provide threaded, flanged, hub, or other end configurations to suit size of valve and piping connections. Provide inside screw type for use with curb valve box, iron body, bronze-mounted, double disc, parallel seat, non-rising stem. Clow Corp., Dresser Mfg., Fairbanks Co., Kennedy, Stockham.

2.9 Hose Bibbs: Provide rough nickel plated hose bibbs with lock shield compression stop and removable handle, solid flange, female connection with ¾" male threaded hose end, and straight line type non-removable vacuum breaker with ¾" male threaded hose end. Acorn 8121 RCP or equal model by Woodford.

2.10 Non-freeze Wall Hydrants: Provide ¾" anti-syphon, non-freeze wall hydrant with bronze casing, satin bronze box, straight inlet connection, and integral vacuum breaker-backflow preventer, Wade W-8625 or approved equal.

2.11 Water Hammer Arresters: Provide bellows type water hammer arresters, stainless steel casing and bellows, pressure rated for 250 psi, tested and certified in accordance with PDI Standard WH-201. Precision Plumbing Products, Josam, Zurn, Amtrol, Wade, Jay R. Smith, or approved equal.

2.12 Meters and Gauges: Provide meters and gauges complying with Division-23 Basic Mechanical Materials and Methods section "Meters and Gauges", in accordance with the following listing:

Thermometers
Pressure gauges
Calibrated balancing cocks

2.13 Combined Pressure-Temperature Relief Valves: Provide relief valves as indicated, of size and capacity as selected by Installer for proper relieving capacity, in accordance with ASME Boiler and Pressure Vessel Code. Provide bronze body, test lever and thermostat complying with ANSI Z21.22 listing requirements for temperature discharge capacity. Provide temperature relief at 210°F, and pressure relief at 150 psi. Watts, Cash, Zurn, or approved equal.

2.14 Trap Primers: Provide brass trap primers and distribution units to seal floor drains indicated on drawings. Trap primer valves shall be automatic, self contained type with no springs or diaphragms and shall not require adjustment. Trap primer valves shall be the type that can be installed anywhere on cold water piping. Distribution units shall supply 1-4 floor drains. Trap primer valves shall comply with ASSE 1018. Precision Plumbing Products PR-500, or approved equal. Where P-trap primers are indicated use "Prime-Eze" by Jay R. Smith, or approved equal.

2.15 Access Doors: Provide access doors to service all valves and other devices as required in accordance with Division-23 Basic Materials and Methods Section “Access Doors”.

3 EXECUTION

3.1 General: Examine areas and conditions under which potable water systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 Install plumbing identification in accordance with Division-23 Basic Mechanical Materials and Methods section "Mechanical Identification". Install underground plastic pipe markers

during backfill, 6"-8" below grade.

3.3 Install water distribution piping in accordance with Division-23 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings".

3.3.1 Install piping with 1/32" per foot (¼%) downward slope towards drain point.

3.3.2 Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

3.4 Install exterior water piping in compliance with local governing regulations. Water piping shall be installed with a minimum of 30 inches of cover unless otherwise indicated.

3.5 Install piping specialties in accordance with Division-23 Basic Mechanical Materials and Methods section "Piping Specialties".

3.6 Install supports and anchors in accordance with Division-23 Basic Mechanical Materials and Methods section "Supports and Anchors".

3.7 Install valves in accordance with Division-23 Basic Mechanical Materials and Methods section "Valves".

3.7.1 Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves two or more plumbing fixtures or equipment connections, and elsewhere as indicated.

3.7.2 Shutoff Valves: Install on inlet of each plumbing equipment item, and on inlet of each plumbing fixture, and elsewhere as indicated.

3.7.3 Drain Valves: Install on each plumbing equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain potable water system.

3.7.4 Check Valves: Install where indicated.

3.7.5 Calibrated Balancing Cocks: Install in each hot water recirculating loop, and elsewhere as indicated.

3.8 Hose Bibbs and Wall Hydrants: Install on concealed piping where indicated with vacuum breaker. Mount 18 inches above grade or finished floor.

3.9 Install pressure regulating valves where indicated. Provide inlet and outlet shutoff valves, and throttling valve bypass. Provide pressure gauge on valve outlet.

3.10 Install meters and gauges in accordance with Division-23 Basic Mechanical Materials and Methods section "Meters and Gauges".

3.11 Install relief valves on each water heater, and where indicated in accordance with the manufacturer's instructions. Pipe full size outside or to floor drain. Cut the end of the pipe at a 45° angle and terminate 6 inches above the floor or grade.

3.12 Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes

indicated, but in no case smaller than required by Florida Building Code-Plumbing.

3.13 Plumbing Equipment Connections: Connect hot and cold water piping system to plumbing equipment as indicated, and comply with equipment manufacturer's installation instructions. Provide shutoff valve and union for each connection, provide drain valve on drain connection.

3.14 Install water hammer arresters in upright position, in locations and of sizes indicated in accordance with PDI Standard WH-201.

3.15 Install trap primers as indicated, and in accordance with manufacturer's installation instructions. Provide access panels to all trap primers unless accessible through a lay-in ceiling.

3.16 Locate and coordinate installation of access doors for all valves and devices in accordance with Division-23 Basic Mechanical Materials and Methods section “Access Doors”.

3.17 Piping Tests: Test, clean, and sterilize potable water piping in accordance with testing requirements of Division-23 Basic Mechanical Materials and Methods section "Testing, Cleaning, and Sterilization of Piping Systems".

**END OF SECTION 22 11 13**

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# SECTION 22 13 16 - SOIL, WASTE AND VENT SYSTEM

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-22 Basic Plumbing Requirements and Basic Plumbing Materials and Methods sections apply to work of this section.

1.3 Division-23 Basic Mechanical Materials and Methods Sections apply to work of this section.

1.4 Extent of soil waste and vent systems work is indicated on drawings and schedules, and by requirements of this section.

1.5 Refer to appropriate Division-2 sections for exterior sanitary sewer system required in conjunction with soil and waste systems; not work of this section.

1.6 Insulation for soil and waste systems is specified in other Division-22 sections, and is included as work of this section. Insulation requirements include:

1.6.1 Horizontal above grade waste pipes receiving discharge from ice machines, coolers, freezers or similar units to points of connection receiving waste from 4 or more fixtures.

1.6.2 Horizontal above grade waste pipes receiving condensate from air conditioning equipment to point of connection receiving waste from 4 or more fixtures.

1.7 Excavation and backfill required in conjunction with soil, waste and vent piping is specified in other Division-23 sections and is included as work of this section.

1.8 Code Compliance: Comply with applicable portions of Florida Building Code-Plumbing pertaining to plumbing materials, construction and installation of products. Comply with local utility requirements.

1.9 Approval Submittals:

1.9.1 Product Data: Submit manufacturer's technical product data for:

Cleanouts
Floor drains

1.10 O&M Data Submittals: Submit a copy of all approval submittals.

2 PRODUCTS

2.1 General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in soil and waste systems. Where more than one type of materials or products is indicated, selection is Installer's option.

Underground-Type Plastic Line Marker: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide green tape with black printing reading "CAUTION SEWER LINE BURIED BELOW".

2.2 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following listed for each item.

2.3 Pipes and Fittings: Provide pipes and pipe fittings complying with Division-23 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings", in accordance with the following listing:

2.3.1 Above Ground Soil, Waste, and Vent Piping:

2.3.1.1 Polyvinyl chloride plastic pipe (PVC); Type DWV; PVC plastic type DWV socket-type fitting, solvent cement joints. Do not use in fire-rated assemblies or return air plenums.

2.3.2 Underground Building Drain Piping (within 5 feet of the building):

2.3.2.1 Pipe Size 6" and Smaller: Polyvinyl chloride sewer pipe (PVC); Type DWV; PVC plastic type DWV socket-type.

2.4 Pipe Specialties: Provide piping specialties complying with Division-23 Basic Materials and Methods section "Piping Specialties".

2.5 Supports and Anchors: Provide supports and anchors complying with Division-23 Basic Mechanical Materials and Methods section "Supports and Anchors".

2.6 Cleanouts: Provide factory-fabricated drainage piping products of size and type indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements and governing regulations. Josam, Jay R. Smith, Wade, Zurn.

2.6.1 Cleanout Plugs: Cast-bronze or brass, threads complying with ANSI B2.1 countersunk head.

2.6.2 Cleanouts for Cast-Iron Piping Systems:

2.6.2.1 Floor Cleanouts: Cast-iron body with adjustable head, brass plug, and scoriated nickel-brass cover. Furnish with carpet flange for carpeted floors. Furnish with recessed cover for tile floors. Furnish with clamping ring for floors with waterproof membrane. Wade W-6000 spigot outlet for Ty-Seal hub, W-6010 inside caulk, or W-6030 hub outlet for push-on as required.

2.6.2.2 Cleanouts in Piping: Cast-iron cleanout ferrule with threaded brass countersunk plug for caulked piping, Wade W-8550-D. For no-hub piping, furnish no-hub ferrule with W-8590-D threaded brass countersunk plug.

2.6.2.3 Wall Cleanouts: Cast-iron ferrule with tapped, countersunk, threaded brass plug. Square 8.75”x8.75” hinged wall access cover, with scoriated nickel bronze finish.

2.6.2.4 Grade Cleanouts: Cast-iron cleanout ferrule with threaded brass countersunk plug. Wade W-

8530-D. In sidewalks and other finished concrete, provide access cover frames with a non-tilting tractor cover. Wade W-7035-Z or equal.

2.6.2.5 Cleanouts in Paved Areas: Cast iron body, adjustable housing, ferrule with plug and round loose scoriated tractor cover. Wade W-8300-MF. Coordinate concrete depth at site with adjustable flange.

2.6.3 Cleanout for PVC Systems:

2.6.3.1 Floor Cleanouts: Cast-iron body with adjustable head, brass plug, and scoriated nick-brass cover. Furnish with carpet flange for carpeted floors. Furnish with recessed cover for tile floors. Furnish with clamping ring for floors with membrane. Wade W-6030 hub outlet for push-on.

2.6.3.2 Cleanouts in Piping: PVC cleanout adaptor with threaded PVC plug.

2.6.3.3 Wall Cleanouts: PVC cleanout adaptor with tapped, countersunk, threaded brass plug. Square 8.75”x8.75” hinged wall access cover, with scoriated nickel bronze finish.

2.6.3.4 Grade Cleanouts: PVC cleanout adaptor with countersunk, threaded brass plug. Wade W-8590-D plug. In sidewalks and other finished concrete, provide access cover frames with a non-tilting tractor cover. Wade W-7035-Z or equal.

2.6.3.5 Cleanouts in Paved Areas: Cast iron body, adjustable housing, ferrule with plug and round loose scoriated tractor cover. Wade W-8300-MF. Coordinate concrete depth at site with adjustable flange.

2.7 Floor Drains: Provide floor drains of size as indicated on drawings; and type, including features, as specified herein. Josam, Jay R. Smith, Wade, Zurn.

2.7.1 Floor Drains: Provide inside caulk bottom outlet or TY-Seal hub outlet with adaptor for cast iron trap installation and a 4" deep trap seal. Provide clamping rings for floors with membrane.

2.7.2 Strainer: Provide 5" satin-nickel bronze strainer.

2.7.3 Trap Primer Connection: Provide ½" trap primer tapping.

2.7.4 Funnel: Provide funnel where shown on the drawings.

2.7.5 Basis of Design: Wade Series 1100.

3 EXECUTION

3.1 Examine substrates and conditions under which soil and waste systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 Piping Installation:

3.2.1 Install above grade soil and waste piping in accordance with Division-23 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings", and with Florida Building Code-Plumbing.

3.2.2 Install underground soil and waste pipes as indicated and in accordance with Florida Building Code-Plumbing. Lay underground piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Clean interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.2.3 Install building soil and vent piping pitched to drain at minimum slope of ¼" per foot (2%) for piping smaller than 3", and 1/8" per foot (1%) for piping 3" and larger.

3.3 Install piping specialties in accordance with Division-23 Basic Mechanical Materials and Methods section "Piping Specialties".

3.4 Install supports and anchors in accordance with Division-23 Basic Mechanical Materials and Methods section "Supports and Anchors".

3.5 Installation of Cleanouts: Install in above ground piping and building drain piping as indicated, as required by Florida Building Code-Plumbing; and at each change in direction of piping greater than 45°; at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping; and at base of each vertical soil or waste stack. Install floor and wall cleanout covers for concealed piping, select type to match adjacent building finish.

3.5.1 Size: Cleanouts shall be full size up to 4". Piping over 4" shall have a reducing fitting to accommodate a 4" cleanout unless indicated otherwise on drawings.

3.5.2 Install cleanouts to allow adequate clearance for rodding.

3.5.3 Protect all finished surfaces of cleanouts with a suitable adhesive covering until construction is completed.

3.5.4 Cleanouts to Grade: Provide an 18" x 18" x 8" thick concrete pad around the cleanout. Set the cleanout ferrule, adapter, or access cover frame in the concrete as required. The cleanout shall be extended to the finished grade. The concrete pad shall slope away from the cleanout in all directions approximately one inch. Cover pad with fill to finished grade.

3.5.5 Cleanouts in Paved Areas: Provide concrete pad similar to cleanout to grade and coordinate concrete depth at site with adjustable flange. Access cover frames are required.

3.6 Flashing Flanges: Install flashing flange and clamping device with each stack and cleanout passing through waterproof membranes.

3.7 Vent Flashing Sleeves: Install on stack passing through roof, secure to stack flashing in accordance with manufacturer’s instructions. For metal roofs, sleeves and flashing are by Division-7.

3.8 Installation of Floor Drains: Install floor drains in accordance with manufacturer's written instructions and in locations indicated.

3.8.1 Coordinate flashing work with work of waterproofing and adjoining substrate work.

3.8.2 Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.

3.8.3 Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

3.8.4 Position drains so that they are accessible and easy to maintain.

3.9 Connection of Trap Primers: Connect trap primers as indicated, and in accordance with manufacturer's installation instructions. Pitch piping towards drain trap, minimum of 1/8" per foot (1%). Adjust trap primer for proper flow.

3.10 Piping Runouts to Fixtures: Provide soil and waste piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated, but in no case smaller than required by Florida Building Code-Plumbing.

3.11 Test, clean, flush, and inspect soil and waste piping in accordance with requirements of Division-23 Basic Mechanical Materials and Methods section "Testing, Cleaning and Sterilization of Piping Systems".

**END OF SECTION 22 13 16**

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# SECTION 22 30 00 - PLUMBING FIXTURES, EQUIPMENT, TRIM & SCHEDULE

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-22 Basic Plumbing Requirements and Basic Plumbing Materials and Methods sections apply to work of this section.

1.3 Divison-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.4 Extent of plumbing fixtures work required by this section is indicated on drawings and schedules, and by requirements of this section.

1.5 Refer to Division-26 sections for field-installed electrical wiring required for plumbing fixtures; not work of this section.

1.6 Codes and Standards:

1.6.1 Plumbing Fixture Standards: Comply with applicable portions of Florida Building Code-Plumbing pertaining to materials and installation of plumbing fixtures.

1.6.2 ANSI Standards: Comply with applicable ANSI standards pertaining to plumbing fixtures and systems.

1.6.3 PDI Compliance: Comply with standards established by PDI pertaining to plumbing fixture supports.

1.6.4 UL Listing: Construct plumbing fixtures requiring electrical power in accordance with UL standards and provide UL-listing and label.

1.6.5 ARI Compliance: Construct and install water coolers in accordance with ARI Standard 1010 "Drinking-Fountains and Self-Contained Mechanically-Refrigerated Drinking-Water Coolers", and provide Certification Symbol.

1.6.6 ANSI Compliance: Construct and install barrier-free plumbing fixtures in accordance with ANSI Standard A117.1 "Specifications for Making Buildings and Facilities Accessible To and Usable By Physically Handicapped People".

1.7 Approval Submittals:

1.7.1 Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, furnished specialties and accessories; and installation instructions. Submit manufacturer's assembly-type drawings indicating dimensions, roughing-in requirements, required clearances, and methods of assembly of components and anchorages. The submittal shall be organized by “fixture number” and each fixture package shall be so identified. Each fixture package shall include all of the required fitting and trim, even if such devices are used for more than one fixture.

1.8 O&M Data Submittals: Submit a copy of approval submittals. Submit maintenance data and parts lists for each type of plumbing fixture and accessory; including "trouble-shooting"

maintenance guide. Include these data in O&M manual.

1.9 Handle plumbing fixtures carefully to prevent breakage, chipping and scoring fixture finish. Do not install damaged plumbing fixtures; replace and return damaged units to equipment manufacturer.

2 PRODUCTS

2.1 General: Provide factory-fabricated fixtures of type, style and material indicated. For each type fixture, provide trim, carrier, seats, and valves as specified. Where not specified, provide products as recommended by manufacturer, and as required for complete installation. Where more than one type is indicated, selection is Installer's option; but, all fixtures of same type must be furnished by single manufacturer. Where type is not otherwise indicated, provide fixtures complying with governing regulations.

2.2 Model Numbers: Basis of design model numbers of a particular manufacturer are listed in the fixture schedule as an aid to contractors. Where conflicts between the model number and the written description occur, the written description shall govern. Where acceptable manufacturers are listed, products are subject to compliance with requirements.

2.3 Refer to plumbing construction documents for fixture specifications.

2.4 Materials:

2.4.1 Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces which exhibit pitting seam marks, roller marks, foundry sand holes, stains, decoloration, or other surface imperfections on finished units are not acceptable.

2.4.2 All fixtures shall be white vitreous china unless otherwise specifically noted. Where enameled iron fixtures are specified, they shall be furnished with acid resisting enamel.

2.4.3 Where fittings, trim and accessories are exposed or semi-exposed provide bright chrome-plated or polished stainless steel units. Provide copper or brass where not exposed.

2.4.4 Stainless Steel Sheets: ASTM A 167, Type 302/304, hardest workable temper. Finish shall be No. 4, bright, directional polish on exposed surfaces.

2.4.5 Vitreous China: High quality, free from fire cracks, spots, blisters, pinholes and specks; glaze exposed surfaces, and test for crazing resistance in accordance with ASTM C 554.

2.4.6 Synthetic Stone: High quality, free from defects, glaze on exposed surfaces, stain resistant.

2.5 Plumbing Fittings, Trim and Accessories:

2.5.1 Faucets: At locations where water is supplied (by manual, automatic or remote control), provide commercial quality chrome-plated, cast-brass faucets, valves, or other dispensing devices, of type and size indicated, and as required to operate as indicated.

2.5.1.1 Automatic Faucets: Provide electronic sensor-operated faucets with 0.5 gpm vandal-resistant spray head. Set volume adjustment at 0.25 gallons per operation. Provide box-mounted, hard-wired transformer (120 VAC primary - 24 VAC secondary) with each faucet.

All wiring and electrical connections shall be provided by Division - 26.

2.5.1.2 Aerators: Provide aerators of types approved by Health Department having jurisdiction.

2.5.1.3 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following for each item. American Standard, Chicago Faucet Co., Kohler Co., Speakman Co., T & S Brass and Bronze Works, Water Saver Faucet Co.

2.5.2 Stops: Provide chrome-plated brass, angle type, manual shutoff valves and d" chrome-plated flexible supply pipes to permit fixture servicing without shutdown of water supply piping systems for all fixtures. Coordinate with fixture requirements.

2.5.2.1 Provide loose key stops.

2.5.2.2 Provide standard stops.

2.5.2.3 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following for each item. Zurn or approved equal.

2.5.3 Waste Outlets: Provide removable P-traps, drains, waste arms, tailpieces and wastes-to-wall where drains are indicated for direct connection to drainage system for all fixtures unless otherwise noted. Provide drains, tailpieces and waste arms where indirect drains are indicated. Waste outlets shall be full size of fixture drain connection.

2.5.3.1 Provide chrome-plated cast-brass P-traps and drains with cleanout.

2.5.3.2 P-traps, wastes and drains of all types shall be 17-gauge.

2.5.3.3 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following for each item. Zurn, or approved equal.

2.5.4 Flush Valves: Provide quiet-flush, chrome-plated, cast-brass flush valves with vacuum breaker and screwdriver stop. Where handicap service is indicated, provide ADA compliant handles with the handle on the wide side of the stall.

2.5.4.1 Automatic Flush Valves: Provide self-adaptive, electronic, infrared-sensor operated flush valves with 24 volt solenoid operator and override button. Provide a box-mounted, hard-wired transformer (120 VAC primary - 24 VAC secondary) with each flush valve. Provide matching wall cover plates each with four vandal-resistant screws. All wiring and electrical connections shall be provided by Division - 26.

2.5.4.2 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following for each item. Sloan Valve Co. or Zurn.

2.5.5 Carriers: Provide cast-iron supports for fixtures of either graphitic gray iron, ductile iron, or malleable iron or steel as indicated. Coordinate with specific fixture requirements and conditions of the project.

2.5.5.1 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following for each item. Josam, Wade, Zurn, J.R. Smith.

2.5.6 Fixture Bolt Caps: Provide manufacturer's standard exposed fixture bolt caps finished to

match fixture finish.

2.5.7 Escutcheons: Where fixture supplies and drains penetrate walls in exposed locations, provide chrome-plated brass escutcheons with friction clips.

2.5.8 Comply with additional fixture requirements listed for each fixture and as required for a complete and functional system.

2.6 Water Closets:

2.6.1 General: Provide white china siphon jet type unless otherwise noted.

2.6.1.1 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following for each item. American Standard, Crane, Kohler, or Zurn.

2.6.2 Fixture Seats: Provide white, heavy molded plastic fixture seats with stainless steel self-sustaining check hinges.

2.6.2.1 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following for each item. Bemis Mfg. Co., Beneke Corp., Church or Comfort Seats.

2.7 Urinals:

2.7.1 General: Provide white china siphon jet wall hung type with ¾" top spud and 2" outlet unless otherwise noted. Provide short foot carrier with top and bottom hanger plates.

2.7.2 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following for each item. American Standard, Crane, Kohler, or Zurn.

2.8 Lavatories:

2.8.1 General: Provide white china lavatories.

2.8.2 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following for each item. American Standard, Crane, Kohler, or Zurn.

2.9 Electric Water Coolers:

2.9.1 General: Provide self-contained electric water cooler with entire water system free of lead. All joints shall be made using silver solder. Units shall be complete with an air-cooled refrigeration system consisting of a hermetic compressor, cooler, pre-cooler, condenser fan, thermostat safety controls and all other related devices. The unit shall have a capacity of 8 gallons per hour. The cabinet shall be stainless steel with vermin proof insulation. The top shall be fabricated of stainless steel with a No. 4 finish. Provide sensor, operator, transformer and all related controls for fully automatic operation. Where handicap units are indicated, the bubbler and fountain shall be ADA compliant.

2.9.2 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following for each item. Elkay Mfg. Co., Halsey Taylor Div., Haws Drinking Faucet Co., Sunroc, Oasis.

2.10 Mop Receptors:

2.10.1 General: Provide one piece mop receptors with 3" integral stainless steel grid drain. Provide wall-mounted faucet with arm handles, vacuum breaker, stops, hose connection and hose bracket. Provide 30" hose.

2.10.2 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following for each item. Stern-Williams Co., or Acorn.

2.11 Stainless Steel Sinks:

2.11.1 General: Provide Type 304, 18 gauge self-rimming stainless steel back ledge with No. 4 finish . Provide sound deadening material on the sides and bottom of the sink. Provide grid drain or strainer with removable crumb cup and stopper as indicated.

2.11.2 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following for each item. Elkay, Just

2.12 Showers:

2.12.1 General:

2.12.2 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following for each item. Leonard Valve Co., MCC Powers Process Controls, Symmons, Speakman Co.

2.13 Water Heaters:

2.13.1 Electric Water Heaters: See Fixture Schedule on Drawings

2.13.2 Accessories: VB, relief, pan, stand, etc.

2.13.3 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following for each item. Ruud, Rheem, Mor-Flo, State, A.O. Smith.

2.14 Thermostatic Mixing Valves:

2.14.1 General:

2.14.2 Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following for each item. Zurn, Watts, or approved equal.

3 EXECUTION

3.1 Examine roughing-in work of potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates, and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping, and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 Install plumbing fixtures of types indicated where shown and at indicated heights. Install in

accordance with fixture manufacturer's written instructions, roughing-in drawings, and with recognized industry practices. Install in accordance with ADA and applicable handicap code requirements. Ensure that plumbing fixtures comply with requirements and serve intended purposes. Comply with applicable requirements of Florida Building Code-Plumbing pertaining to installation of plumbing fixtures. Furnish templates for cut-outs in countertops. Coordinate exact fixture locations with countertop shop drawings.

3.3 Fasten plumbing fixtures securely to indicated supports or building structure; and ensure that fixtures are level and plumb. Secure plumbing supplies behind or within wall construction so as to be rigid, and not subject to pull or push movement. Mount at heights shown on the drawings. Fixture heights are floor-to-rim distance. Fitting heights are to centerline.

3.4 Install stop valve in water supply to each fixture.

3.5 After fixtures are set, the crack between the fixture and wall shall be caulked with DAP silicone-based caulking, or approved equal.

3.6 Protect installed fixtures from damage during remainder of construction period.

3.7 Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

3.8 Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by Architect/Engineer. Remove cracked or dented units and replace with new units.

3.9 Clean plumbing fixtures, trim, aerators, and strainers of dirt and debris upon completion of installation.

3.10 Adjust water pressure at drinking fountains, faucets, shower valves, and flush valves to provide proper flow stream and specified gpm.

3.11 Adjust or replace washers to prevent leaks at faucets and stops.

**END OF SECTION 22 30 00**

# SECTION 22 62 00 - MEDICAL VACUUM SYSTEM

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-15 Basic Materials and Methods sections apply to work of this section.

1.3 This section refers to medical vacuum systems only.

1.4 Refer to Division-16 sections for the following work; not work of this section.

1.4.1 Power supply wiring from power source to power connection on vacuum producers and other devices. Include disconnects, and required electrical devices, except where specified as furnished, or factory installed, by manufacturer.

1.5 Provide the following as part of this section's work, complying with the requirements of Division 16.

1.5.1 Alarm and signal wiring.

1.6 Codes and Standards: Provide systems and components which are listed by Underwriters Laboratories and comply with NFPA-99.

1.7 Approval Submittals:

M

1.7.1 Product Data: Submit manufacturer's specifications, drawings, installation and start-up instructions, and performance data for the following:

Vacuum producers
Valves
Zone valve boxes
Alarm panels
Alarm system devices
Access doors

1.8 Test Reports and Verification Submittals:

1.8.1 Submit brazer's certificate.

1.8.2 Certifications: Submit certificate by medical vacuum equipment supplier that all cross-connection tests, pressure tests, cleaning, purging, purity tests, equipment tests, operational tests, outlet tests and alarm tests have been completed and are satisfactory.

1.9 O&M Data Submittals:

1.9.1 Wiring Diagrams: Submit manufacturer's electrical requirements for wiring to vacuum producers and alarm system. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Submit wiring diagrams for alarm panels. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

1.9.2 Maintenance Data: Submit a copy of approval submittals and maintenance data and parts lists for each vacuum producer, control, alarm panel, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, and wiring diagrams in O&M manual.

2 PRODUCTS

2.1 General: Provide equipment, piping materials, and factory-fabricated piping products of types, sizes, pressure ratings, temperature ratings, and capacities indicated. Where not indicated, provide proper selection as determined by Installer to comply with the installation requirements. Provide materials and products complying with NFPA-99. Provide sizes and types of pipe and equipment to match existing pipe and materials to the extent possible.

2.2 Acceptable Manufacturers: Subject to compliance with requirements, provide products manufactured by or approved equal.

2.3 Piping: Provide hard drawn, seamless, Type L copper tubing complying with ASTM B88. Provide brazed copper fittings or threaded fittings as indicated. Provide brazing materials per ANSI A5.8. Use brazing filler alloy or solder with a melting point of 450°F or greater.

2.4 Valves: Provide quarter turn, bolted union ball shutoff valves constructed of brass or bronze, solder type. Ball seats shall be constructed of Buna-N or Teflon and shall wipe the ball clean on each operation. Provide blowout-proof stem. Valves shall be cleaned for oxygen service and capped. Valve handles shall be labeled for vacuum service.

2.5 Zone Valve Boxes: Provide extruded aluminum recessed valve boxes with plaster frames, label holders and labels identifying vacuum, concealed mounting screws, and tinted, transparent, frangible window with pull ring. Valve boxes shall contain the quantity and type valves for vacuum and gases as shown on the drawings. Valve boxes shall house valves and 1-1/2" line vacuum gauges.

2.6 Vacuum Service Outlets: Provide recessed vacuum service outlets manufactured per NFPA standards. Outlets shall be of modular design. Provide outlets that are factory tested leak free, cleaned and tested, with vacuum specific, non-interchangeable parts. Outlets shall be labeled. Provide brushed stainless steel finish plate and chrome-plated cover plate. Provide wall/headboard or ceiling outlets as required. For ceiling outlets, provide color-coded conductive hose assemblies and retractor kits. Construct hoses of neoprene able to withstand 200 psi. Terminate hose bottom ends with appropriate hex nut and gland connection. Hose shall extend to 6'-4" above finished floor. Terminate hose with safety-keyed check unit or "Hand-I-Twist" check unit. Coordinate with medical gas service outlets.

2.7 Alarm Panels: Provide modular alarm panels with audible and noncancellable visual alarms with pressure gauges. Provide a closed-circuit, self-monitoring alarm system with provisions for testing. Construct roughing-in box of extruded aluminum with plaster frame. Provide chrome-plated and painted cover. Power supply shall be 120 VAC. Provide master and area alarm panels as shown on the drawings. Alarms shall include:

Oxygen Line Pressure Low
Oxygen Line Pressure High
Oxygen Liquid Level Low - Reorder

Oxygen Emergency Reserve Low
Nitrogen Line Pressure Low
Nitrogen Line Pressure High
Nitrogen Reserve Supply In Use
Vacuum Line Vacuum Below Normal
Nitrous Oxide Line Pressure Low
Nitrous Oxide Line Pressure High
Nitrous Oxide Reserve Supply In Use
Air Line Pressure High
Air Line Pressure Low
Air Dryer Dewpoint Alarm

2.8 Alarm System Devices

2.8.1 Vacuum Switch: Provide SPDT, snap action switch cleaned per NFPA-99 with electrical terminals. Rate switches for 5 amps at 240 VAC. Switches shall be tested at 30 in. Hg. vacuum. Switches shall be adjustable with external dials over a range of 30 in. Hg. to 10 psi. Provide NEMA-1 housing.

2.8.2 Vacuum Gauges: Provide 1-1/2" diameter gauges with 1/4" NPT threaded connector. Calibration shall be 0-30 in. Hg.

2.8.3 Orifice Nipples: Provide brass orifice nipples for vacuum switches with 1/4" NPT male threads at each end.

2.9 Medical Vacuum Producers: Provide factory-tested, continuous duty rated, base-mounted, packaged, duplex medical vacuum producer assembly that requires only air intake, air discharge, and one electrical connection. Basis of Design: or approved equal meeting NFPA-99 with the following features:

2.9.1 Motors: ODP. High efficiency per Division-15 section “Motors”.

2.9.2 Starter: UL-listed, duplex system in NEMA-12 cabinet with circuit breakers, magnetic starters, overloads, HOA switches, hour meters, and timer/alternator to cycle vacuum producers at timed intervals.

2.9.3 Vacuum Pumps: Belt-drive, reciprocating, single stage, single acting, air cooled, with unloaders and Teflon piston and rider rings. Provide 24-month warranty. The system shall not require cooling water.

2.9.4 Safety Devices: Provide thermal overload protection with alarm to master panel for each vacuum producer.

2.9.5 Package Piping: Type K or L copper tubing with brazed joints per NFPA-99. Provide vacuum pump isolation valves on suction and discharge. Provide in-line, canister type filter/silencer on suction. Provide check valve, pressure relief valve and isolation ball valve on each discharge manifold.

2.9.6 Maintenance: Provide service by the supplier available at any time with 24 hour guaranteed response time.

2.9.7 Cabinet: Provide removable sound attenuating cabinet that provides for system cooling.

Maximum 75 dB(A).

2.9.8 Air Receiver: Provide ASME code stamped, National Board registered receiver with pressure relief valve, drain, pressure gauge, and automatic drain trap.

2.9.9 Provide discharge muffler.

2.9.10 Provide piping specialties, supports and anchors, complying with other Division-15 sections.

2.10 Vibration Isolation: Provide vibration isolation complying with Division-15 Basic Materials and Methods section “Vibration Isolation”, and in accordance with the following listing:

2.10.1 Vacuum Pump Mounting: EM5.

2.10.2 Vacuum Pump Suction and Discharge Piping: PF5.

2.11 Access Doors: Provide access doors to service all valves and other devices as required in accordance with Division-15 Basic Materials and Methods Section “Access Doors”.

3 EXECUTION

3.1 Install piping, pipe fittings, piping specialties, valves, gauges and supports and anchors complying with other Division-15 sections as modified herein.

3.2 Install underground piping in duct or casing. Install piping in combustible partitions in conduit. Firestop all piping.

3.3 All joints in concealed piping shall be soldered or brazed. Flared or compression fittings are allowed only on tubing 1/2" and smaller that is visible in rooms. All threaded joints shall be tinned with soft solder. Tube bends 45° or less shall be made with bending tools. Tube bends over 45° shall be made with fittings.

3.4 Individually support piping as follows:

| | |
|---|---|
| Smaller than 1/2" | 6' on center horizontal |
| 3/4" to 1" | 8' on center horizontal |
| 1-1/4" and larger | 10' on center horizontal |
| All piping | at each floor vertical |

3.5 Install service valves in main, at base of risers and where shown on the drawings. Label service valves and lock open.

3.6 Clean all piping, fittings, and components free of oil, grease, and other materials. Do not use carbon tetrachloride.

3.7 Label all vacuum piping prior to installation.

3.8 Wash the outside of all tubing, joints, and fittings with hot water.

3.9 Locate groups of pipes parallel to each other, spaced to permit servicing valves. All branches and outlets shall be taken from the top of the main.

3.10 Locate and coordinate installation of access doors for all valves and devices in accordance with Division-15 Basic Mechanical Materials and Methods section “Access Doors”.

3.11 Install vacuum producer on reinforced concrete base. Set and level unit on vibration isolators. Install flexible connectors and all accessories. Install and start units in accordance with manufacturer's instructions. Pipe drains to nearest floor drain with copper tubing.

3.12 Provide startup service for vacuum producers.

3.13 Install all alarm panels, vacuum switches, gauges, valves, zone valve boxes, outlets, and other devices per NFPA-99 and the manufacturer's instructions.

3.14 Check entire system for correctness of operation, installation, control sequencing, and alignment. Start all components in proper sequence. Make adjustments required to insure proper smooth quiet operation.

3.15 Performance Criteria and Testing:

3.15.1 Perform cross-connection test per NFPA-99 to verify no cross-connections exist to any other system.

3.15.2 Verify labeling at station outlets, valves, and panels.

3.15.3 After piping is installed (but before installing station outlets, gauges, vacuum switches, and vacuum pumps) blow the system clear with nitrogen or oil-free dry air.

3.15.4 Pressure test to 150 psi with nitrogen or oil-free dry air before closing walls. Test vacuum system individually.

3.15.5 Install all components except vacuum pump, then test at 60 psi for 24 hours.

3.15.6 Test each terminal outlet for 3 cfm of flow at 12 in. Hg.

3.15.7 Perform vacuum drop test on each section of the system. Test fails if vacuum drops greater than 1.5 in. Hg./hr at 12 in. Hg.

3.15.8 Test vacuum producers and accessories.

3.15.9 Test all alarms - master and area.

3.15.10 Set vacuum producers to maintain 12 in. Hg. at the most remote terminal.

3.16 Notify Architect/Engineer, Owner, and Contractor of all tests one week in advance so tests can be witnessed.

3.17 A qualified representative of the medical vacuum equipment supplier shall inspect the entire installation, perform startup services, witness all tests, check all outlets and alarms, and certify in writing that the system is installed correctly. Furnish three copies of the certification letter to the Architect/Engineer prior to final inspection.

END OF SECTION

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# SECTION 22 63 00 - MEDICAL GAS SYSTEMS

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-15 Basic Materials and Methods sections apply to work of this section.

1.3 This section refers to medical gases including:

Oxygen
Nitrogen
Nitrous Oxide
Air

1.4 Refer to Division-16 sections for the following work; not work of this section.

1.4.1 Power supply wiring from power source to power connection on air compressors and other devices. Include disconnects, and required electrical devices, except where specified as furnished, or factory installed, by manufacturer.

1.5 Provide the following as part of this section's work, complying with the requirements of Division 16.

1.5.1 Alarm and signal wiring.

1.6 Codes and Standards: Provide systems and components which are listed by Underwriters Laboratories and comply with NFPA-99. All components and materials used in systems for oxygen and nitrous oxide shall be oxygen compatible.

1.7 Approval Submittals:

1.7.1 Product Data: Submit manufacturer's technical product and performance data for the following:

Valves
Zone valve boxes
Gas service outlets
Cylinders
Alarm panels
Nitrogen pressure control cabinets
Alarm system devices
Medical air accessories
Access doors

1.8 Test Reports and Verification Submittals:

1.8.1 Submit brazer’s certificates.

1.8.2 Certifications: Submit certificate by medical gas equipment supplier that all cross-

connection tests, pressure tests, cleaning, purging, purity tests, equipment tests, operational tests, outlet tests and alarm tests have been completed and are satisfactory.

1.9 O&M Data Submittals:

1.9.1 Wiring Diagrams: Submit manufacturer's electrical requirements for wiring to air compressors and alarm systems. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Submit wiring diagrams for alarm panels. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

1.9.2 Maintenance Data: Submit a copy of approval submittals. Submit maintenance data and parts lists for each control, alarm panel, and accessory ; including "trouble-shooting" maintenance guide. Include these data and wiring diagrams in O&M manual.

2 PRODUCTS

2.1 General: Provide equipment, piping materials, and factory-fabricated piping products of types, sizes, pressure ratings, temperature ratings, and capacities indicated. Where not indicated, provide proper selection as determined by Installer to comply with the installation requirements. Provide materials and products complying with NFPA-99. Provide sizes and types of pipe and equipment to match existing pipe and materials to the extent possible.

2.2 Acceptable Manufacturers: Subject to compliance with requirements, provide products manufactured by or approved equal.

2.3 Piping: Provide hard drawn, seamless, Type L copper tubing complying with ASTM B88. Tubing shall be delivered to the jobsite cleaned and capped for oxygen service per NFPA-99. Provide brazed copper fittings or threaded fittings as indicated. Provide brazing materials per ANSI A5.8. Use copper-phosphorous brazing filler alloy (BCuP) without flux, with a melting point of 1000°F or greater.

2.4 Valves: Provide quarter turn, bolted union ball shutoff valves constructed of brass or bronze, solder type. Ball seats shall be constructed of Buna-N or Teflon and shall wipe the ball clean on each operation. Provide blowout-proof stem. Valves shall be cleaned for oxygen service and capped. Valve handles shall be labeled for gas service.

2.5 Zone Valve Boxes: Provide extruded aluminum recessed valve boxes with plaster frames, label holders and labels identifying gases, concealed mounting screws, and tinted, transparent, frangible window with pull ring. Valve boxes shall contain the quantity and type valves for gases as shown on the drawings. Valve boxes shall house valves and 1½" line pressure gauges.

2.6 Gas Service Outlets: Provide recessed gas service outlets manufactured per NFPA and CGA standards. Outlets shall be of modular design. Provide outlets that are factory tested leak free, cleaned and tested for oxygen service, and with gas specific, non-interchangeable parts. Outlets shall identify type of gas. Provide primary valve and secondary check. Provide brushed stainless steel finish plate and chrome-plated cover plate. Provide wall/headboard or ceiling outlets as required. For ceiling outlets, provide color-coded conductive hose assemblies and retractor kits. Construct hoses of neoprene able to withstand 200 psi. Terminate hose bottom ends with appropriate hex nut and gland connection. Hose shall extend to 6'-4" above finished floor. Terminate hose with safety-keyed check unit or "Hand-I-Twist" check unit.

2.7 Cylinders: Provide cylinders constructed and tested per DOT specifications and labeled per ANSI Z48.1. Number of cylinders is shown on the drawings. Provide racks and fasteners. Provide cylinder manifolds, cylinder pressure relief valves, pressure switches, gauges, cylinder check valves, isolation valves, pressure regulators and automatic changeover controls as required. Cylinder valve outlets, manifold, and regulator inlets shall comply with ANSI B57.1 and shall insure noninterchangeability. Pressure relief valves shall be constructed of bronze or brass designed especially for gas service. Set relief valves at 150% of normal line pressure, except for nitrogen if used for tools, etc. (set at 150% or 200 psi, whichever is lower). Provide cylinder connection pig tails of copper tubing with brazed fittings.

2.8 Alarm Panels: Provide modular alarm panels with audible and noncancellable visual alarms with pressure gauges. Provide a closed-circuit, self-monitoring alarm system with provisions for testing. Construct roughing-in box of extruded aluminum with plaster frame. Provide chrome-plated and painted cover. Power supply shall be 120 VAC. Provide master and area alarm panels as shown on the drawings. Alarms shall include:

Oxygen Line Pressure Low
Oxygen Line Pressure High
Oxygen Liquid Level Low - Reorder
Oxygen Emergency Reserve Low
Nitrogen Line Pressure Low
Nitrogen Line Pressure High
Nitrogen Reserve Supply In Use
Vacuum Line Vacuum Below Normal
Nitrous Oxide Line Pressure Low
Nitrous Oxide Line Pressure High
Nitrous Oxide Reserve Supply In Use
Air Line Pressure High
Air Line Pressure Low
Air Dryer Dewpoint Alarm

2.9 Recessed Nitrogen Pressure Control Cabinets: Provide recessed nitrogen pressure control cabinets with prime-painted steel backbox with mounting flanges and anchoring provisions. Cabinets shall contain a line-pressure control regulator, two pressure gauges (supply and outlet), nitrogen service outlet and supply valve. The coverplate shall be stainless steel with control identifications and pressure control and supply valve knobs.

2.10 Alarm System Devices

2.10.1 High-Low Pressure Switch (for oxygen, nitrous oxide, air): Provide dual circuit, SPDT, snap action switch cleaned per NFPA-99, pre-wired with six 18" lengths of color-coded wire. Rate switches for 10 amps at 120 VAC. Switches shall be tested for 180 psi. Switches shall be adjustable with external calibrated dials and tamper-proof cover. Provide NEMA-4 housing.

2.10.2 High-Low Pressure Switch (Nitrogen): Provide dual circuit, SPDT, snap action switch cleaned per NFPA-99 with electrical terminals. Rate switches for 5 amps at 240 VAC. Switches shall be tested for 900 psi. Switches shall be adjustable with external calibrated dials. Provide NEMA-1 housing.

2.10.3 Pressure Gauges: Provide 1½" diameter gauges with 2/3" MNPT threaded, center back connector. Calibration shall be 0-100 psi, except for nitrogen service, which shall be 0-400 psi.

2.10.4 Orifice Nipples: Provide brass orifice nipples for pressure switches with ¼" NPT male threads at each end.

2.11 Access Doors: Provide access doors to service all valves and other devices as required in accordance with Division-15 Basic Materials and Methods Section "Access Doors".

3 EXECUTION

3.1 Install piping, pipe fittings, piping specialties, valves, gauges and supports and anchors complying with other Division-15 sections as modified herein.

3.2 Install piping that is in combustible partitions in conduit. Firestop all piping.

3.3 All joints in concealed piping shall be brazed. Flared or compression fittings are allowed only on tubing ½" and smaller that is visible in rooms. All threaded joints shall be tinned with soft solder. Tube bends 45° or less shall be made with bending tools. Tube bends over 45° shall be made with fittings.

3.4 Individually support piping as follows:

| | |
|---|---|
| Smaller than ½" | 6' on center horizontal |
| ¾" to 1" | 8' on center horizontal |
| 1¼" and larger | 10' on center horizontal |
| All piping | at each floor vertical |

3.5 Install service valves in main, at base of riser and where shown on the drawings. Label service valves and lock open.

3.6 Locate and coordinate installation of access doors for all valves and devices in accordance with Division-15 Basic Mechanical Materials and Methods section "Access Doors".

3.7 Clean all piping, fittings, and components free of oil, grease, and other oxidizable materials as if for oxygen service. Do not use carbon tetrachloride. Clean per CGA Pamphlet G-4.1 "Cleaning Equipment for Oxygen Service". Deliver all tubing to the jobsite cleaned and capped. Inspect prior to use. All components requiring cleaning at the jobsite shall be cleaned by washing in a hot alkaline cleaner-water solution, scrubbed, then rinsed in clean, hot water.

3.8 Purge with nitrogen during brazing.

3.9 Wash the outside of all tubing, joints, and fittings with hot water.

3.10 Install tubing to station outlets as follows in accordance with NFPA 99

3.11 Locate groups of pipes parallel to each other, spaced to permit servicing valves. All branches and outlets shall be taken from the top of the main.

3.12 Install air compressor on reinforced concrete base. Set and level unit on vibration isolation pads. Install flexible connectors and all accessories. Install and start units in accordance with manufacturer's instructions. Pipe drains to nearest floor drain with copper tubing.

3.13 Provide startup service for air compressors. Verify air quality test on startup and after 24 hours of operation.

3.14 Install all alarm panels, pressure switches, gauges, valves, zone valve boxes, outlets, cylinders, and other devices per NFPA-99 and the manufacturer's instructions.

3.15 Check entire system for correctness of operation, installation, control sequencing, and alignment. Start all components in proper sequence. Make adjustments required to insure proper smooth quiet operation.

3.16 Performance Criteria and Testing

3.16.1 Perform cross-connection test per NFPA-99 to verify no cross-connections exist to any other system.

3.16.2 Verify labeling at station outlets, valves, and panels.

3.16.3 After piping is installed (but before installing station outlets, gauges, pressure switches, manifolds, and reliefs) blow the system clear with nitrogen or oil-free dry air.

3.16.4 Pressure test to 150 psi with nitrogen or oil-free dry air before closing walls. Test gas systems individually.

3.16.5 Install all components then test at 120% of normal operating pressure for 24 hours.

3.16.6 Purge the system with the proper gas progressively through all outlets at 100 l/min until a white cloth shows no discoloration.

3.16.7 Test each outlet with oxygen or other gas to confirm the desired percentage of oxygen or the proper gas.

3.16.8 Test changeover and reserve signals for all cylinders.

3.16.9 Test pressure relief valves.

3.16.10 Test air compressors and accessories.

3.16.11 Perform purity test for air quality.

3.16.12 Test all alarms - master and area.

3.16.13 Set central gas supplies to maintain 50-55 psi, except nitrogen. Set nitrogen central supplies to maintain 160 psi at the outlets.

3.17 Notify Architect/Engineer, Owner, and Contractor of all tests one week in advance so tests can be witnessed.

3.18 A qualified representative of the medical gas equipment supplier shall inspect the entire

installation, perform startup services, witness all tests, check all outlets and alarms, and certify in writing that the system is installed correctly. Furnish three copies of the certification letter to the Architect/Engineer prior to final inspection.

END OF SECTION

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# SECTION 23 01 00 - MECHANICAL GENERAL

1 GENERAL

1.1 The work covered by this division consists of providing all labor, equipment and materials and performing all operations necessary for the installation of the mechanical work as herein called for and shown on the drawings.

1.2 Related Documents:

1.2.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2.2 This is a Basic Mechanical Requirements Section. Provisions of this section apply to work of all Division 23 sections.

1.2.3 Review all other contract documents to be aware of conditions affecting work herein.

1.2.4 Definitions:

1.2.4.1 Provide: Furnish and install, complete and ready for intended use.

1.2.4.2 Furnish: Supply and deliver to project site, ready for subsequent requirements.

1.2.4.3 Install: Operations at project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar requirements.

1.3 Permits and Fees: Contractor shall obtain all necessary permits, meters, and inspections required for his work and pay all fees and charges incidental thereto.

1.4 Verification of Owner's Data: Prior to commencing any work the Contractor shall satisfy himself as to the accuracy of all data as indicated in these plans and specifications and/or as provided by the Owner. Should the Contractor discover any inaccuracies, errors, or omissions in the data, he shall immediately notify the Architect/Engineer in order that proper adjustments can be anticipated and ordered. Commencement by the Contractor of any work shall be held as an acceptance of the data by him after which time the Contractor has no claim against the Owner resulting from alleged errors, omissions or inaccuracies of the said data.

1.5 Delivery and Storage of Materials: Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. All material shall be stored to provide protection from the weather and accidental damage.

1.6 Extent of work is indicated by the drawings, schedules, and the requirements of the specifications. Singular references shall not be constructed as requiring only one device if multiple devices are shown on the drawings or are required for proper system operation.

1.7 Field Measurements and Coordination:

1.7.1 The intent of the drawings and specifications is to obtain a complete and satisfactory installation. Separate divisional drawings and specifications shall not relieve the Contractor

or subcontractors from full compliance of work of his trade indicated on any of the drawings or in any section of the specifications.

1.7.2 Verify all field dimensions and locations of equipment to insure close, neat fit with other trades' work. Make use of all contract documents and approved shop drawings to verify exact dimension and locations.

1.7.3 Coordinate work in this division with all other trades in proper sequence to insure that the total work is completed within contract time schedule and with a minimum cutting and patching.

1.7.4 Locate all apparatus symmetrical with architectural elements. Install to exact height and locations when shown on architectural drawings. When locations are shown only on mechanical drawings, be guided by architectural details and conditions existing at job and correlate this work with that of others.

1.7.5 Install work as required to fit structure, avoid obstructions, and retain clearance, headroom, openings and passageways. Cut no structural members without written approval.

1.7.6 Carefully examine any existing conditions, piping, and premises. Compare drawings with existing conditions. Report any observed discrepancies. It shall be the Contractor's responsibility to properly coordinate the work and to identify problems in a timely manner. Written instructions will be issued to resolve discrepancies.

1.7.7 Because of the small scale of the drawings, it is not possible to indicate all offsets and fittings or to locate every accessory. Drawings are essentially diagrammatic. Study carefully the sizes and locations of structural members, wall and partition locations, trusses, and room dimensions and take actual measurements on the job. Locate piping, ductwork, equipment and accessories with sufficient space for installing and servicing. Contractor is responsible for accuracy of his measurements and for coordination with all trades. Contractor shall not order materials or perform work without such verification. No extra compensation will be allowed because field measurements vary from the dimensions on the drawings. If field measurements show that equipment or piping cannot be fitted, the Architect/Engineer shall be consulted. Remove and relocate, without additional compensation, any item that is installed and is later found to encroach on space assigned to another use.

1.8 Guarantee:

1.8.1 The Contractor shall guarantee labor, materials and equipment for a period of one (1) year from Final Completion, or from Owner's occupancy, whichever is earlier. Contractor shall make good any defects and shall include all necessary adjustments to and replacement of defective items without expense to the Owner.

1.8.2 Owner reserves right to make emergency repairs as required to keep equipment in operation without voiding Contractor's Guarantee Bond nor relieving Contractor of his responsibilities during guarantee period.

1.9 Approval Submittals:

1.9.1 When approved, the submittal control log and submittals shall be an addition to the specifications herewith, and shall be of equal force in that no deviation will be permitted except with the approval of the Architect/Engineer.

1.9.1.1 Shop drawings, product literature, and other approval submittals will only be reviewed if they are submitted in full accordance with the General and Supplementary Conditions and Division 1 Specification sections and the following.

1.9.1.1.1 Submittals shall be properly organized in accordance with the approved submittal control log.

1.9.1.1.2 Submittals shall not include items from more than one specification section in the same submittal package unless approved in the submittal control log.

1.9.1.1.3 Submittals shall be properly identified by a cover sheet showing the project name, Architect and Engineer names, submittal control number, specification section, a list of products or item names with model numbers in the order they appear in the package, and spaces for approval stamps. A sample cover sheet is included at the end of this section.

1.9.1.1.4 Submittals shall have been reviewed and approved by the General Contractor (or Prime Contractor). Evidence of this review and approval shall be an "Approved" stamp with a signature and date on the cover sheet.

1.9.1.1.5 Submittals that include a series of fixtures or devices (such as plumbing fixtures or valves) shall be organized by the fixture number or valve type and be marked accordingly. Each fixture must include all items associated with that fixture regardless of whether or not those items are used on other fixtures.

1.9.1.1.6 The electrical design shown on the drawings supports the mechanical equipment basis of design specifications at the time of design. If mechanical equipment is submitted with different electrical requirements, it is the responsibility of the mechanical contractor to resolve all required electrical design changes (wire and conduit size, type of disconnect or overload protection, point(s) of connection, etc.) and clearly show the new electrical design on the mechanical submittal with a written statement that this change will be provided at no additional cost. Mechanical submittals made with no written reference to the electrical design will be presumed to work with the electrical design. Any corrections required will be at no additional cost.

1.9.2 If the shop drawings show variation from the requirements of contract because of standard shop practice or other reasons, the Contractor shall make specific mention of such variation in writing in his letter of transmittal and on the submittal cover sheet in order that, if acceptable, Contractor will not be relieved of the responsibility for executing the work in accordance with the contract.

1.9.3 Review of shop drawings, product literature, catalog data, or schedules shall not relieve the Contractor from responsibility for deviations from contract drawings or specifications, unless he has in writing called to the attention of the Architect/Engineer each such deviation in writing at the time of submission, nor shall it relieve him from responsibility for errors of any sort in shop drawings, product literature, catalog data, or schedules. Any feature or function specified but not mentioned in the submittal shall be assumed to be included per the specification.

1.9.4 Submit shop drawings as called for in other sections after award of the contract and before any material is ordered or fabricated. Shop drawings shall consist of plans, sections, elevations and details to scale (not smaller than ¼" per foot), with dimensions clearly showing the installation. Direct copies of small scale project drawings issued to the Contractor are not acceptable. Drawings shall take into account equipment furnished under other sections and shall show space allotted for it. Include construction details and materials.

1.10 Test Reports and Verification Submittals: Submit test reports, certifications and verification letters as called for in other sections. Contractor shall coordinate the required testing and documentation of system performance such that sufficient time exists to prepare the reports, submit the reports, review the reports and take corrective action within the scheduled contract time.

1.11 O&M Data Submittals: Submit Operation and Maintenance data as called for in other sections. When a copy of approval submittals is included in the O&M Manual, only the final "Approved" or "Approved as Noted" copy shall be used. Contractor shall organize these data in the O&M Manuals tabbed by specification number. Prepare O&M Manuals as required by Division 1 and as described herein.. Submit manuals at the Substantial Completion inspection.

2 PRODUCTS

2.1 All materials shall be new or Owner-supplied reused as shown on the drawings, the best of their respective kinds, suitable for the conditions and duties imposed on them at the building and shall be of reputable manufacturers. The description, characteristics, and requirements of materials to be used shall be in accordance with qualifying conditions established in the following sections.

2.2 Equipment and Materials:

2.2.1 Shall be new and the most suitable grade for the purpose intended. Equipment furnished under this division shall be the product of a manufacturer regularly engaged in the manufacture of such items for a period of three years. Where practical, all of the components shall be products of a single manufacturer in order to provide proper coordination and responsibility. Where required, Contractor shall furnish proof of installation of similar units or equipment.

2.2.2 Each item of equipment shall bear a name plate showing the manufacturer's name, trade name, model number, serial number, ratings and other information necessary to fully identify it. This plate shall be permanently mounted in a prominent location and shall not be concealed, insulated or painted.

2.2.3 The label of the approving agency, such as UL, IBR, ASME, ARI, AMCA, by which a standard has been established for the particular item shall be in full view.

2.2.4 The equipment shall be essentially the standard product of a manufacturer regularly engaged in the production of such equipment and shall be a product of the manufacturer's latest design.

2.2.5 A service organization with personnel and spare parts shall be available within two hours for each type of equipment furnished.

2.2.6 Install in accordance with manufacturer's recommendations. Place in service by a factory trained representative where required.

2.2.7 Materials and equipment are specified herein by a single or by multiple manufacturers to indicate quality, material and type of construction desired. Manufacturer's products shown on the drawings have been used as basis for design; it shall be the Contractor's responsibility to ascertain that alternate manufacturer's products, or the particular products of named manufacturers, meet the detailed specifications and that size and arrangement of equipment are suitable for installation.

2.2.8 Model Numbers: Catalog numbers and model numbers indicated in the drawings and specifications are used as a guide in the selection of the equipment and are only listed for the contractor's convenience. The contractor shall determine the actual model numbers for ordering materials in accordance with the written description of each item and with the intent of the drawings and specifications.

2.2.9 All equipment and material shall be manufactured and assembled in the United States.

2.3 Requests for Substitution:

2.3.1 Where a particular system, product or material is specified by name, consider it as standard basis for bidding, and base proposal on the particular system, product or material specified.

2.3.2 Requests by Contractor for substitution will be considered only when reasonable, timely, fully documented, and qualifying under one or more of the following circumstances.

2.3.2.1 Required product cannot be supplied in time for compliance with Contract time requirements.

2.3.2.2 Required product is not acceptable to governing authority, or determined to be non-compatible, or cannot be properly coordinated, warranted or insured, or has other recognized disability as certified by Contractor.

2.3.2.3 Substantial cost advantage is offered Owner after deducting offsetting disadvantages including delays, additional compensation for redesign, investigation, evaluation and other necessary services and similar considerations.

2.3.3 All requests for substitution shall contain a "Comparison Schedule" and clearly and specifically indicate any and all differences or omissions between the product specified as the basis of design and the product proposed for substitution. Differences shall include but shall not be limited to data as follows for both the specified and substituted products:

Principal of operation.
Materials of construction or finishes.
Thickness of gauge of materials.
Weight of item.
Deleted features or items.
Added features or items.
Changes in other work caused by the substitution.
Performance curves.

If the approved substitution contains differences or omissions not specifically called to the attention of the Architect/Engineer, the Owner reserves the right to require equal or similar features to be added to the substituted products (or to have the substituted products replaced) at the Contractor's expense.

3 EXECUTION

3.1 Workmanship: All materials and equipment shall be installed and completed in a first-class workmanlike manner and in accordance with the best modern methods and practice. Any materials installed which do not present an orderly and reasonably neat and/or workmanlike appearance, or do not allow adequate space for maintenance, shall be removed and replaced when so directed by the Architect/Engineer.

3.2 Coordination:

3.2.1 The Contractor shall be responsible for full coordination of the mechanical systems with shop drawings of the building construction so the proper openings and sleeves or supports are provided for piping, ductwork, or other equipment passing through slabs or walls.

3.2.2 Any additional steel supports required for the installation of any mechanical equipment, piping, or ductwork shall be furnished and installed under the section of the specifications requiring the additional supports.

3.2.3 It shall be the Contractor's responsibility to see that all equipment such as valves, dampers, filters and such other apparatus or equipment that may require maintenance and operation are made easily accessible, regardless of the diagrammatic location shown on the drawings.

3.2.4 All connections to fixtures and equipment shown on the drawings shall be considered diagrammatic unless otherwise indicated by detail. The actual connections shall be made to fully suit the requirements of each case and adequately provide for expansion and servicing.

3.2.5 The contractor shall protect equipment, material, and fixtures at all times. He shall replace all equipment, material, and fixtures which are damaged as a result of inadequate protection.

3.2.6 Prior to starting and during progress of work, examine work and materials installed by others as they apply to work in this division. Report conditions which will prevent satisfactory installation.

3.2.7 Start of work will be construed as acceptance of suitability of work of others.

3.3 Interruption of Service: Before any equipment is shut down for disconnecting or tie-ins, arrangements shall be made with the Architect/Engineer and this work shall be done at the time best suited to the Owner. This will typically be on weekends and/or holidays and/or after normal working hours. Services shall be restored the same day unless prior arrangements are made. All overtime or premium costs associated with this work shall be included in the base bid.

3.4 Phasing: Provide all required temporary valves, piping, ductwork, equipment and devices as required. Maintain temporary services to areas as required. Remove all temporary

material and equipment on completion of work unless Engineer concurs that such material and equipment would be beneficial to the Owner on a permanent basis.

3.5 Cutting and Patching: Notify General Contractor to do all cutting and patching of all holes, chases, sleeves, and other openings required for installation of equipment furnished and installed under this section. Utilize experienced trades for cutting and patching. Obtain permission from Architect/Engineer before cutting any structural items.

3.6 Equipment Setting: Bolt equipment directly to concrete pads or vibration isolators as required, using hot-dipped galvanized anchor bolts, nuts and washers. Level equipment.

3.7 Painting: Touch-up factory finishes on equipment located inside and outside shall be done under Division 23. Obtain matched color coatings from the manufacturer and apply as directed. If corrosion is found during inspection on the surface of any equipment, clean, prime, and paint, as required.

3.8 Clean-up: Thoroughly clean all exposed parts of apparatus and equipment of cement, plaster, and other materials and remove all oil and grease spots. Repaint or touch up as required to look like new. During progress of work, contractor is to carefully clean up and leave premises and all portions of building free from debris and in a clean and safe condition.

3.9 Start-up and Operational Test: Start each item of equipment in strict accordance with the manufacturer's instructions; or where noted under equipment specification, start-up shall be done by a qualified representative of the manufacturer. Alignment, lubrication, safety, and operating control shall be included in start-up check.

3.10 Climate Control: Operate heating and cooling systems as required after initial startup to maintain temperature and humidity conditions to avoid freeze damage and warping or sagging of ceilings and carpet.

3.11 Record Drawings:

3.11.1 During the progress of the work the Contractor shall record on their field set of drawings the exact location, as installed, of all piping, ductwork, equipment, and other systems which are not installed exactly as shown on the contract drawings.

3.11.2 Upon completion of the work, record drawings shall be prepared as described in the General Conditions, Supplementary Conditions, and Division 1 sections.

3.12 Acceptance:

3.12.1 Punch List: Submit written confirmation that all punch lists have been checked and the required work completed.

3.12.2 Instructions: At completion of the work, provide a competent and experienced person who is thoroughly familiar with project, for one day to instruct permanent operating personnel in operation of equipment and control systems. This is in addition to any specific equipment operation and maintenance training.

3.12.3 Operation and Maintenance Manuals: Furnish four complete manuals bound in ring binders with Table of Contents, organized, and tabbed by specification section. Manuals shall contain:

Detailed operating instructions and instructions for making minor adjustments.
Complete wiring and control diagrams.
Routine maintenance operations.
Manufacturer's catalog data, service instructions, and parts lists for each piece of operating equipment.
Copies of approved submittals.
Copies of all manufacturer's warranties.
Copies of test reports and verification submittals.

3.12.4 Record Drawings: Submit record drawings.

3.12.5 Test and Balance Report: Submit four certified copies. The Report shall be submitted for review prior to the Substantial Completion Inspection unless otherwise required by Division 1.

3.12.6 Acceptance will be made on the basis of tests and inspections of job. A representative of firm that performed test and balance work shall be in attendance to assist. Contractor shall furnish necessary mechanics to operate system, make any necessary adjustments and assist with final inspection.

3.12.7 Control Diagrams: Frame under glass and mount on equipment room wall.

**END OF SECTION 23 01 00**

# SECTION 23 05 13 - ELECTRIC MOTORS

1 GENERAL

1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Section apply to work of this Section.

1.2 This section is a Division 23 Basic Mechanical Materials and Methods section, and is part of each Division 23 section making reference to motors specified herein.

1.3 Extent of motors required by this section is indicated on drawings and/or specified in other Division-23 sections.

1.4 Comply with the requirements of Division 26.

1.5 UL Compliance: Comply with applicable UL standards pertaining to motors.

1.6 Approval Submittals:

1.6.1 Product Data: When required by other Division-23 sections, submit manufacturers standard product data sheets for each type of motor provided. Submit with Division-23 section using the motors, not as a separate submittal. Mark data sheet with arrows indicating product being supplied and list by unique descriptive name all motors to which each data sheet applies. Clearly indicate type, service factor, rpm, duty cycle, voltage, phase, nominal full load efficiency, power factor and insulation class. Field verify and coordinate mounting and frame requirements for matching the drive.

1.7 O&M Data Submittals: Submit a copy of approval submittals. Submit operation and maintenance data for each type of motor. Include these data in O&M Manual. Submit two copies of nameplate data sheet for each motor. One copy shall be included with the O&M Manual and a second copy shall be inserted in a waterproof pouch or bag and attached to the motor. Nameplate data sheets shall be typed or neatly printed and shall include all data on the motor nameplate plus a unique motor description such as "AHU-3 Fan Motor", "Distribution Pump #1" or similar description.

2 PRODUCTS

2.1 Acceptable Manufacturers: Subject to compliance with requirements, General Electric, Baldor, US Electric, or approved equal.

2.2 General:

2.2.1 Motors shall conform to applicable portions of NEMA Standard MG-1, Motors and Generators.

2.2.2 Motors shall be sized for the application such that when the driven equipment is operated at rated capacity the motor current will not exceed the full-load nameplate current. Service factor shall not be used in normal operation.

2.3 Motor Design:

2.3.1 Integral Horsepower Motors:

2.3.1.1 Motors shall be open drip-proof or totally enclosed fan cooled as shown on the drawings or listed in the Division 23 section requiring motors.

2.3.1.2 Motors shall be three phase, 60 hertz, nominal 1800 rpm, rated at 200 volts for 208 volt systems, 230 volts for 240 volt systems and 460 volts for 480 volt systems.

2.3.1.3 Motors shall be NEMA Design B and shall have 1.15 service factor or greater at 60 hertz.

2.3.1.4 Insulation Systems

2.3.1.4.1 In fixed speed applications, motors shall have Class B insulation with 80ºC rise over 40ºC ambient.

2.3.1.4.2 For variable frequency drive (VFD) applications, motors shall have Class F insulation with 105ºC rise over 40ºC ambient. Motor manufacturer shall identify motors being used for VFD applications by marking the motor with a stainless steel name-plate “Inverter Duty”. Motors shall be provided with one set of thermostatic sensors.

2.3.1.5 Motor efficiencies shall be based on IEEE-112, 1984, Test Method B, as specified in NEMA Standard MG1-12.53. NEMA motor efficiency and power factor shall be clearly shown on the motor nameplate. Inverter duty motors shall have a CIV rating based on NEMA.

2.3.1.6 Motors shall be premium efficiency type and shall meet or exceed the following minimum nominal efficiencies at rated voltage.

230/460 VOLT, 3 PHASE

| HORSEPOWER RANGE | MINIMUM NOMINAL EFFICIENCY | MINIMUM ACCEPTABLE POWER FACTOR |
|---|---|---|
| 1 to 2 hp | 84.0 pct. | 75.0 pct |
| 3 to 5 hp | 87.5 pct. | 77.0 pct |
| 7.5 hp | 89.5 pct. | 80.0 pct |
| 10 hp | 90.2 pct. | 80.0 pct |
| 15 hp | 91.0 pct. | 82.0 pct |
| 20 to 25 hp | 92.0 pct. | 82.0 pct |
| 30 hp | 92.4 pct. | 82.0 pct |
| 40 to 50 hp | 93.0 pct. | 85.0 pct |
| 60 hp | 93.6 pct. | 85.0 pct |
| 75 hp | 94.1 pct. | 85.0 pct |
| 100 to 125 hp | 94.5 pct. | 85.0 pct |
| 150 to 200 hp | 95.0 pct. | 85.0 pct |
| over 200 hp | 95.4 pct. | 87.0 pct |

200 VOLT, 3 PHASE

| HORSEPOWER RANGE | MINIMUM NOMINAL EFFICIENCY | MINIMUM ACCEPTABLE POWER FACTOR |
|---|---|---|
| 1 to 2 hp | 84.0 pct. | 75.0 pct |
| 3 to 5 hp | 87.5 pct. | 77.0 pct |
| 7.5 hp | 89.5 pct. | 80.0 pct |
| 10 hp | 90.2 pct. | 80.0 pct |
| 15 hp | 91.0 pct. | 80.0 pct |
| 20 to 25 hp | 92.0 pct. | 80.0 pct |

2.3.1.7 Motors 25 hp and larger which are to be installed outdoors or in other high humidity areas shall be equipped with silicone rubber space heaters. Space heaters shall be energized when motor is de-energized.

2.3.2 Fractional Horsepower Motors one-half hp and above:

2.3.2.1 Motors shall be open drip-proof or totally enclosed fan cooled as shown on the drawings or listed in the Division 23 section requiring motors.

2.3.2.2 Motors shall be three phase, 60 hertz, nominal 1800 rpm, rated at 200, 230 or 460 volts as shown on the drawings.

2.3.2.3 Motors shall be NEMA Design B with class B insulation, unless used with variable frequency drives.

2.3.3 Fractional Horsepower Motors less than one-half hp:

2.3.3.1 Motors shall be single phase, 60 hertz, rated at 120 volts with integral thermal protection.

2.4 Overload Protection: Properly sized overload protection shall be provided for each motor. This protection may be an integral part of the motor or may be part of the motor controller and shall interrupt each ungrounded conductor.

3 EXECUTION

3.1 Motor Size and Location:

3.1.1 Size and location of motors shown on the drawings are based on a particular design and may change with a different manufacturer. Submittal of shop drawings or product literature indicating motor sizes or locations different from that designed indicates that Contractor has fully coordinated any required changes to the electrical system with other trades. Approval (if made) is on this basis and no additional cost will be allowed for any changes.

3.1.2 Contractor shall verify and make any necessary adjustments to electrical service, branch circuit wiring, branch circuit protection, overload protection, disconnect and controller

(starter), or VFD based on actual nameplate data of the motors supplied prior to installation. Where applicable, connect motor winding thermostat to VFD.

3.2 Motor Voltages: Contractor shall field verify system voltage prior to ordering or installing any motors. Submittal of shop drawings or product literature indicating motor voltages indicates that Contractor has fully coordinated the motor with the electrical system and that any discrepancies have been resolved. Approval (if made) is on this basis and no additional cost will be allowed for any changes.

3.3 Motor Mounting: Adjust motor mounting as required to adjust the drive train for proper belt operation and to accommodate sheave changes or other requirements of the test and balance work.

3.4 Motor Mounting: Install the new motor and mounting hardware as required to properly drive the existing equipment. Provide all necessary hardware and modifications to the existing equipment necessary to achieve a system that has the proper alignment and can drive the equipment in a smooth, quiet, vibration-free manner. Provide for proper servicing of the motor and drive.

**END OF SECTION 23 05 13**

# SECTION 23 05 20 - PIPES AND PIPE FITTINGS

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 This section is a Division-23 Basic Mechanical Materials and Methods section, and is part of each Division-23 section making reference to pipes and pipe fittings specified herein.

1.3 Extent of pipes and pipe fittings required by this section is indicated on drawings and/or specified in other Division-23 sections.

1.4 Codes and Standards:

1.4.1 Welding: Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9, as applicable, for shop and project site welding of piping work.

1.4.2 Brazing: Certify brazing procedures, brazers, and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, for shop and job-site brazing of piping work.

1.4.3 NSF Labels: Where plastic piping is indicated to transport potable water, provide pipes and pipe fittings bearing approval label by National Sanitation Foundations (NSF).

1.5 Test Report and Verification Submittals:

1.5.1 Submit welding certification for all welding installers.

1.5.2 Submit brazing certification for all brazing installers.

2 PRODUCTS

2.1 Piping Materials: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.

2.2 Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

2.3 Piping Materials/Products:

2.3.1 Soldering Materials:

2.3.1.1 Tin-Antimony (95-5) Solder: ASTM B-32, Grade 95TA.

2.3.1.2 Silver-Phosphorus Solder: ASTM B-32, Grade 96TS.

2.3.2 Pipe Thread Tape: Teflon tape.

2.3.3 Protective Coating: Koppers Bitumastic No. 505 or equal.

2.3.4 Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast iron flanges; raised-face for steel flanges, unless otherwise noted.

2.3.5 Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials. Materials shall be determined by installer to comply with installation requirements.

2.3.6 Brazing Materials: Silver content of not less than 15%. Materials shall be determined by installer to comply with installation requirements.

2.4 Copper Tube and Fittings:

2.4.1 Copper Tube:

2.4.1.1 Copper Tube: ASTM B88; Type K or L as indicated for each service; hard-drawn temper unless specifically noted as annealed.

2.4.1.2 ACR Copper Tube: ASTM B280.

2.4.2 Fittings:

2.4.2.1 Wrought-Copper Solder-Joint Fittings: ANSI B16.22.

2.4.2.2 Copper Tube Unions: Provide standard products recommended by manufacturer for use in service indicated.

2.4.2.3 Cast-Copper Flared Tube Fittings: ANSI B16.26.

2.5 Steel Pipes and Pipe Fittings

2.5.1 Pipes:

2.5.1.1 Black Steel Pipe: ASTM A-53 or A-120, seamless.

2.5.1.2 Galvanized Steel Pipe: ASTM A-53 or A-120, seamless.

2.5.2 Pipe Fittings:

2.5.2.1 Threaded Cast Iron: ANSI B16.4.

2.5.2.2 Threaded Malleable Iron: ANSI B16.3; plain or galvanized as indicated.

2.5.2.3 Malleable Iron Threaded Unions: ANSI B16.39; selected by installer for proper piping fabrication and service requirements including style, end connections, and metal-to-metal seats (iron, bronze or brass); plain or galvanized as indicated.

2.5.2.4 Threaded Pipe Plugs: ANSI B16.14.

2.5.2.5 Flanged Cast Iron: ANSI B16.1, including bolting.

2.5.2.6 Steel Flanges/Fittings: ANSI B16.5, including bolting and gasketing.

2.5.2.7 Wrought-Steel Buttwelding Fittings: ANSI B16.9, except ANSI B16.28 for short radius elbows and returns, rated to match connected pipe.

2.5.2.8 Pipe Nipples: Fabricated from same pipe as used for connected pipe; except do not use less than schedule 80 pipe where length remaining unthreaded is less than 1 ½ inches, and where pipe size is less than 1 ½ inches, and do not thread nipples full length (no close-nipples).

2.6 Plastic Pipes and Fittings:

2.6.1 Pipes:

2.6.1.1 PVC DWV Pipe: ASTM D-2665, Schedule 40.

2.6.1.2 PVC Sewer Pipe: ASTM D-3034.

2.6.2 Fittings:

2.6.2.1 PVC Solvent Cement: ASTM D-2564.

2.6.2.2 PVC DWV Socket: ASTM D-2665.

2.6.2.3 PVC Sewer Socket: ASTM D-3034.

3 EXECUTION

3.1 Installation

3.1.1 General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leak proof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance or replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings, not bushings. Align piping accurately at connections, within 1/16" misalignment tolerance.

3.1.2 Comply with ANSI B31 Code for Pressure Piping.

3.1.3 Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent-enclosure elements of building; limit clearance to ½" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1" clearance outside insulation.

3.1.4 Concealed Piping: Unless specifically noted as “Exposed” on the drawings, conceal piping from view in finished and occupied spaces, by locating in column enclosures, chases, in

hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.

3.1.5 Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical, communications, or data equipment spaces and enclosures unless shown. Install drip pan under piping that must run through electrical spaces.

3.1.5.1 Cut pipe from measurements taken at the site, not from drawings. Keep pipes free of contact with building construction and installed work.

3.2 Piping System Joints: Provide joints of the type indicated in each piping system.

3.2.1 Solder copper tube-and-fitting joints where indicated, in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply non-acid type solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.

3.2.2 Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed. Paint exposed threads to retard rusting.

3.2.3 Flanged Joints: Match flanges within piping system, and at connection with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets. Bolts shall project 1/8" to 3/8" beyond nut face when tight.

3.2.4 Weld pipe joints in accordance with recognized industry practice and as follows. Be guided by ANSI B.31.

3.2.4.1 Weld pipe joints only when ambient temperature is above 0°F.

3.2.4.2 Bevel pipe ends at a 37.5° angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.

3.2.4.3 Use pipe clamps or tack-weld joints; 4 welds for pipe sizes to 10". All welds shall be open-butt.

3.2.4.4 Build up welds with root pass, followed by filler pass and then a cover pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusions.

3.2.4.5 Do not weld-out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.

3.2.4.6 At Installer's option, install forged branch-connection fittings wherever branch pipe is less than 3" and at least two pipe sizes smaller than main pipe indicated; or install regular "T" fitting. Weld-O-Let or equal.

3.2.4.7 All field welding and cutting using oxygen-acetylene methods within the building shall be performed in accordance with NFPA-51B (1994).

3.2.4.8 Limit the use of welded piping to shop-fabricated only. Neither welding nor cutting with oxygen-acetylene methods will be permitted within the envelope of the hospital building.

3.2.5 Plastic Pipe Joints: Comply with manufacturer's instructions and recommendations, and with applicable industry standards.

3.2.5.1 Solvent-cemented joints shall be made in accordance with ASTM D-2235 and ASTM F-402.

3.2.5.2 PVC sewer pipe bell/gasket joints shall be installed in accordance with ASTM D-2321.

3.2.6 Cast-Iron Joints: Tightly pack joint with joint packing material. Do not permit packing to enter bore of finished joint. Clean joint after packing. Fill remaining joint space with one pouring of lead to indicated minimum depth measured from face of bell. After lead has cooled, calk joint tightly by use of hammer and calking iron. If using compression joints, comply with manufacturer's installation instruction using gaskets and lubricant furnished specifically for this duty.

3.2.7 Braze copper tube-and-fitting joints where indicated, in accordance with ANSI B.31.

3.3 Piping Installation

3.3.1 Install piping to allow for expansion and contraction.

3.3.2 Isolate all copper tubing from steel and concrete by wrapping the pipe at the contact point, and for one inch on each side, with a continuous plastic sleeve. Isolate all copper tubing installed in block walls with a continuous plastic sleeve.

3.3.3 Underground Piping:

3.3.3.1 Provide plastic tape markers over all underground piping. Provide copper wire over all underground plastic piping. Locate markers 18" above piping.

3.3.3.2 Coat the following underground (uninsulated) pipes with a heavy coat of bitumastic or provide an 8 mil polyvinyl sleeve: black steel pipe, galvanized steel pipe, copper tubing.

3.3.3.3 Install underground glass pipes in a protective casing of expanded polystyrene. Underground glass fittings shall be wrapped with protective plastic sheets or bags. Use care to prevent scratching or chipping glass pipes and fittings.

END OF SECTION

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# SECTION 23 05 21 - PIPING SPECIALTIES

1 GENERAL

1.1 Drawings and general provisions of contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 This section is a Division-23 Basic Mechanical Materials and Methods section, and is part of each Division-23 section making reference to or requiring piping specialties specified herein.

1.3 Approval Submittals:

1.3.1 Product Data: Submit product data with installation instructions and UL listing for:

1.3.1.1 Fire barrier sealants.

2 PRODUCTS

2.1 General: Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or if not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.

2.2 Escutcheons:

2.2.1 General: Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.

2.2.2 Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.

2.2.3 Pipe Escutcheons for Dry Areas: Provide sheet steel escutcheons, solid or split hinged.

2.3 Dielectric Unions Waterways: Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action and stop corrosion.

2.4 Fire Barrier Penetration Seals:

2.4.1 Provide seals for any opening through fire-rated walls, floors, or ceilings used as passage for mechanical components such as piping or ductwork in accordance with the requirements of Division 7.

2.4.2 Cracks, Voids, or Holes Up to 4" Diameter: Use putty or calking, one-piece intumescent elastomer, non-corrosive to metal, compatible with synthetic cable jackets, and capable of expanding 10 times when exposed to flame or heat, UL-listed.

2.4.3 Openings 4" or Greater: Use sealing system capable of passing 3-hour fire test in accordance with ASTM E-814, consisting of wall wrap or liner, partitions, and end caps capable of expanding when exposed to temperatures of 250 to 350°F, UL-listed.

2.5 Fabricated Piping Specialties:

2.5.1 Drip Pans: Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top, either by structural angles or by rolling top over ¼" steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1" drain line connection.

2.5.2 Pipe Sleeves: Provide pipe sleeves of one of the following:

2.5.2.1 Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gages: 3" and smaller, 20 gage; 4" to 6" 16 gauge; over 6", 14 gage.

2.5.2.2 Steel-Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

2.5.2.3 Iron-Pipe: Fabricate from cast-iron or ductile-iron pipe; remove burrs.

2.5.3 Sleeve Seals: Provide sleeve seals for sleeves located in foundation walls below grade, or in exterior walls, of one of the following:

2.5.3.1 Caulking and Sealant: Provide foam or caulking and sealant compatible with piping materials used.

2.6 Low Pressure Y-Type Pipeline Strainers:

2.6.1 General: Provide strainers full line size of connecting piping, with ends matching piping system materials. Provide Type 304 stainless steel screens.

2.6.1.1 Water Strainers: Select for 200 psi working pressure (water, oil or gas). Provide 20 mesh screens through 2" size and 1/16" perforations for 2½" size and larger.

2.6.2 Select from the following types:

2.6.2.1 Threaded Ends, 2" and Smaller: Cast-iron body, screwed screen retainer with centered blowdown fitted with pipe plug.

2.6.2.2 Threaded Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.

2.6.2.3 Flanged Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.

3 EXECUTION

3.1 Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.

3.2 Dielectric Unions : Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.

3.3 Fire Barrier Penetration Seals: Provide pipe sleeve as required. Fill entire opening with sealing compound. Adhere to manufacturer's installation instructions. Refer to Division 7.

3.4 Drip Pans: Locate drip pans under piping passing over or within 3' horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" drain line to drain connection, and run to nearest plumbing drain or elsewhere as indicated.

3.5 Pipe Sleeves: Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by Architect/Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but not less than 2 pipe sizes larger than piping run. Where insulation includes vapor-barrier jacket, provide sleeve with sufficient clearance for installation. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves ¼" above level floor finish, and ¾" above floor finish sloped to drain. Provide temporary support of sleeves during placement of concrete and other work around sleeves, and provide temporary closure to prevent concrete and other materials from entering sleeves.

3.5.1 Install sleeves in fire-rated assemblies in accordance with the listing of the assembly and the fire barrier sealant.

3.5.2 Install sheet-metal sleeves at interior partitions and ceilings other than suspended ceilings. Fill annular space with caulking or fire barrier sealant as required.

3.5.3 Install steel-pipe sleeves at floor penetrations. Fill annular space with caulking or fire barrier sealant as required.

3.5.4 Install iron-pipe sleeves at all foundation wall penetrations and at exterior penetrations; both above and below grade. Fill annular space with caulking or mechanical sleeve seals.

3.6 Y-Type Strainers: Install Y-type strainers full size of pipeline, in accordance with manufacturer's installation instructions. Install pipe nipple and shutoff valve in strainer blow down connection, full size of connection, except for strainers ¾" and smaller installed ahead of control valves feeding individual terminals. Where indicated, provide drain line from shutoff valve to plumbing drain, full size of blow down connection.

3.7 Locate Y-type strainers in supply line ahead of the following equipment, and elsewhere as indicated, if integral strainer is not included in equipment:

Pumps

Temperature control valves.
Pressure reducing valves.
Temperature or pressure regulating valves.

END OF SECTION

# SECTION 23 05 23 - VALVES

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to the work of this section.

1.2 This section is a Division-23 Basic Materials and Methods section, and is part of each Division-23 section making reference to or requiring valves specified herein.

1.3 Extent of valves required by this section is indicated on drawings and/or specified in other Division-23 sections.

1.4 Quality Assurance:

1.4.1 Valve Dimensions: For face-to-face and end-to-end dimensions of flanged or welding-end valve bodies, comply with ANSI B16.10.

1.4.2 Valve Types: Provide valves of same type by same manufacturer.

1.4.3 Valve Listing: For valves on fire protection piping, provide UL listing.

1.5 Approval Submittals: When required by other Division-23 sections, submit product data, catalog cuts, specifications, and dimensioned drawings for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valves with Division-23 section using the valves, not as a separate submittal. Submit valve comparison chart with applicable valves clearly marked if valves other than basis-of-design are to be used. For each valve, identify systems where the valve is intended for use.

1.5.1 Gate Valves. Type GA.

1.5.2 Globe Valves. Type GL.

1.5.3 Check Valves. Type CK.

1.5.4 Ball Valves. Type BA.

1.5.5 Butterfly Valves. Type BF.

1.6 O&M Data Submittals: Submit a copy of approval submittals. Submit installation instructions, maintenance data and spare parts lists for each type of valve. Include this data in the O&M Manual.

2 PRODUCTS

2.1 General: Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by Installer to comply with specifications and installation requirements. Provide sizes as indicated, and connections which properly mate with pipe, tube, and equipment connections.

2.2 Acceptable Manufacturers: Subject to compliance with requirements, provide valves of one of the producers listed for each valve type. Other valve manufacturers list names are also acceptable. The model numbers are listed for contractor's convenience only. In the case of a model number discrepancy, the written description shall govern.

2.3 Gate Valves:

2.3.1 Packing: Select valves designed for repacking under pressure when fully opened, equipped with non-asbestos packing suitable for intended service. Select valves designed so back seating protects packing and stem threads from fluid when valve is fully opened, and equipped with gland follower.

2.3.2 Comply with the following standards:

Cast Iron Valves: MSS SP-70. Cast Iron Gate Valves, Flanged and Threaded Ends.
Bronze Valves: MSS SP-80. Bronze Gate, Globe, Angle and Check Valves.
Steel Valves: ANSI B16.34. Steel Standard Class Valve Ratings.

2.3.3 Types of gate (GA) valves:

1 Threaded Ends 2" and Smaller (GA1): Class 125, bronze body, screwed bonnet, rising stem, solid wedge. Stockham B-100. Nibco T-111. Crane 428. Milwaukee 148.

2 Soldered Ends 2" and Smaller (GA2): Class 125, bronze body, screwed bonnet, non-rising stem, solid wedge. Stockham B-108 or B-109. Nibco S-111. Crane 1334. Milwaukee 149.

3 Flanged Ends 2½" and Larger (GA3): Class 125, iron body, bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge. Stockham G-623. Nibco F617-0. Crane 465½. Milwaukee F2885.

4 Threaded Ends 2" and Smaller (GA4): Class 150, bronze body, screwed bonnet, rising stem, solid wedge. Stockham B-122. Nibco T-131. Crane 431. Milwaukee 1150.

5 Soldered Ends 2" and Smaller (GA5): Class 150, bronze body, screwed bonnet, rising stem, solid wedge. Stockham B-124. Nibco S-134. Milwaukee 1169.

6 Threaded Ends 2" and Smaller (GA6): 175 WWP, bronze body, screwed bonnet, rising stem, OS&Y, solid wedge, UL-listed. Stockham B-133. Nibco T-104-0.

7 Flanged Ends 2½" and Larger (GA7): 175 WWP, iron body, bolted bonnet, rising stem, OS&Y, solid wedge, UL listed. Stockham G-634. Nibco F-607-0TS

8 Threaded Ends 2" and Smaller (GA8): Class 200, bronze body, union bonnet, rising stem, solid wedge, renewable seat. Stockham B-132. Nibco T-154-SS. Milwaukee 1174.

9 Flanged Ends 2½" and Larger (GA9): Class 250, iron body bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge. Stockham F-667. Nibco F-667-0. Crane 7½E. Milwaukee F-2894.

10 Threaded Ends 2" and Smaller (GA10): Class 300, bronze body, union bonnet, rising stem, solid wedge, renewable seat. Stockham B-145. Nibco T-174-SS. Crane 634E.

Milwaukee 1184.

11 Flanged Ends 2½" and Larger (GA11): Class 300, cast steel body, bolted bonnet, rising stem, solid wedge, seal-welded seat rings. Provide trim to match use. Stockham 30-0F. Crane 33.

12 Flanged Ends 2½" and Larger (GA12): 300 WWP, iron body, bolted bonnet, bronze mounted, rising stem, OS&Y, solid wedge, UL-listed. Stockham F-670. Nibco F-697-0.

2.4 Check Valves:

2.4.1 Construction: Construct valves of castings free of any impregnating materials. Construct valves with a bronze regrinding disc with a seating angle of 40° to 45°, unless a composition disc is specified. Provide stop plug as renewable stop for disc hanger, unless otherwise specified. Disc and hanger shall be separate parts with disc free to rotate. Support hanger pins on both ends by removable side plugs.

2.4.2 Comply with the following standards:

Cast Iron Valves: MSS SP-71. Cast Iron Swing Check Valves, Flanged and Threaded Ends.
Bronze Valves: MSS SP-80. Bronze Gate, Globe, Angle and Check Valves.
Steel Valves: ANSI B16.34. Steel Standard Class Valve Ratings.

2.4.3 Types of check (CK) valves:

1 Threaded Ends 2" and Smaller (CK1): Class 125, bronze body, screwed cap, horizontal swing, bronze disc. Stockham B-319. Nibco T-413-BY. Crane 1707. Milwaukee 509.

2 Soldered Ends 2" and Smaller (CK2): Class 125, bronze body, screwed cap, horizontal swing, bronze disc. Stockham B-309. Nibco S-413-B. Crane 1707S. Milwaukee 1509.

3 Flanged Ends 2½" and Larger (CK3): Class 125, iron body, bronze-mounted, bolted cap, horizontal swing, cast-iron or composition disc. Stockham G-931 or G-932 as applicable. Nibco F918-B. Crane 373. Milwaukee F2974 as applicable.

4 Threaded Ends 2" and Smaller (CK4): 200 WWP, bronze body, screwed cap, horizontal swing, regrinding type bronze disc, for fire sprinkler use. Nibco KT-403-W.

5 Flanged Ends 2½" and Larger (CK5): 175 WWP, iron body, bolted cap, bronze mounted, composition disc, UL listed, with ball drip if required. Stockham G-940. Nibco F-908-W.

6 Threaded Ends 2" and Smaller (CK6): Class 200, bronze body, screwed cap, Y-pattern swing, regrinding bronze disc. Stockham B-345. Nibco T-453-B. Crane 36. Milwaukee 518/508.

7 Flanged Ends 2½" and Larger (CK7): Class 250, iron body, bronze mounted, bolted cap, cast-iron disc. Stockham F-947. Nibco F-968-B. Crane 39E. Milwaukee F2970.

8 Threaded Ends 2" and Smaller (CK8): Class 300, bronze body, screwed cap, Y-pattern swing, regrinding bronze disc. Stockham B-375. Nibco T-473-B. Crane 76E.

Milwaukee 517/507.

9 Flanged Ends 2½" and Larger (CK9): Class 300, cast steel body, bolted cap, horizontal swing, seal welded seat rings, chromium stainless disc. Stockham 30-SF. Crane 159.

2.5 Ball Valves:

2.5.1 General: Select with port area equal to or greater than connecting pipe area, include seat ring designed to hold sealing material.

2.5.2 Construction: Ball valves shall be rated for 150 psi saturated steam and 600 psi non-shock cold water. Pressure containing parts shall be constructed of ASTM B-584 alloy 844, or ASTM B-124 alloy 377. Valves shall be furnished with blow-out proof bottom loaded stem constructed of ASTM B-371 alloy 694 or other approved low zinc material. Provide TFE packing, TFE thrust washer, chrome-plated ball and reinforced teflon seats. Valves 1" and smaller shall be full port design. Valves 1¼" and larger shall be conventional port design. Stem extensions shall be furnished for use in insulated piping where insulation exceeds ½" thickness.

2.5.3 Comply with the following standards:

MSS SP-72. Ball Valves with Flanged or Butt Welding Ends for General Service.
MSS SP-110. Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

2.5.4 Types of ball (BA) valves:

1 Threaded Ends 2" and Smaller (BA1): Bronze two-piece full port body with adjustable stem packing. Nibco T-585-70. Stockham S216-BR-R-T. Milwaukee BA125. Apollo 77-100.

2 Soldered Ends 2" and Smaller (BA2): Bronze three-piece full port body with adjustable stem packing. Nibco S-595-Y-66. Milwaukee BA350. Apollo 82-200.

3 Threaded Ends 1" and Smaller (BA3): Bronze two-piece full port body, UL listed (UL 842) for use with flammable liquids and LP gas. Nibco T-585-70-UL.

4 Threaded Ends 2" and Smaller (BA4): 175 WWP, bronze two-piece body, UL listed for fire protection service. Nibco KT-585-70-UL and KT-580-70-UL.

5 Threaded Ends 2" and Smaller (BA5): 400 WWP, bronze two-piece body, for fire protection service. Nibco KT-580.

6 Threaded Ends 2½" and Smaller (BA6): 300 WWP, bronze three-piece body, gear operator with handwheel, indicator flag, accepts tamper switch, for fire protection, UL listed. Nibco T-505-4 and G-505-4.

7 Flanged Ends 2½" and Larger (BA7): Class 150, carbon steel full bore two-piece body with adjustable stem packing. Nibco F515-CS series. Apollo 88-240.

2.6 Butterfly Valves:

2.6.1 General: Comply with MSS SP-67, Butterfly Valves. Provide butterfly valves designed for tight shut-off. Where used for terminal or equipment removal or repair, select lug type valves. Select wafer type valves for other applications. Provide gear operators on all butterfly valves 6" and larger.

2.6.2 Types of butterfly (BF) valves:

1 Wafer Type 3" and Larger (BF1): 200 CWP, cast-iron body, lever-operated, cadmium-plated ductile iron disc, Type 410 stainless steel stem, EPT seat. Stockham LG-512. Nibco WD 2110-3. Crane 42-FXB-TL. Milwaukee MW222E-8416.

2 Lug Type 3" and Larger (BF2): 200 CWP, cast-iron body, lever-operated, cadmium-plated ductile iron disc, Type 410 stainless steel stem, EPT seat. Stockham LG-712. Nibco LD 2110-3. Crane 44-FXB-TL. Milwaukee ML132B-8416.

3 Wafer Type 3" and Larger (BF3): 150/200 CWP, cast-iron body, gear-operated, cadmium-plated ductile iron disc, Type 410 stainless steel stem, EPT seat. Stockham LG-522 and LG-521. Nibco WD 2110-5. Crane 42-FXB-G. Milwaukee MW 122B-8115.

4 Lug Type 3" and Larger (BF4): 150/200 CWP, cast-iron body, gear-operated, cadmium-plated ductile iron disc, Type 410 stainless steel stem, EPT seat. Stockham LG-722 and LG-721. Nibco LD 2110-5. Crane 44-FXB-G. Milwaukee ML 132B-8115.

5 Wafer Type 4" and Larger (BF5): 175 WWP, cast-iron body, gear-operated, nickel-plated ductile iron disc, Type 410 stainless steel stem, EPT seat, UL listed. Stockham LG-52U. Nibco WD 3510-8.

6 Lug Type 4" and Larger (BF6): 175 WWP, cast-iron body, gear-operated, nickel-plated ductile iron or aluminum bronze disc, Type 410 stainless steel stem, EPT seat, UL listed. Stockham LG-72U. Nibco LD 3510-8.

7 Grooved Type 4" and Larger (BF7): 175 WWP, cast-iron body, gear-operated, nickel-plated ductile iron or aluminum bronze disc, Type 410 stainless steel stem, EPT seat, UL listed. Stockham LG-82U. Nibco GD 1765-2.

2.7 Valve Features:

2.7.1 General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features as determined by Installer for installation requirements. Comply with ANSI B31.1

2.7.2 Valve features specified or required shall comply with the following:

1 Flanged: Provide valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).

2 Threaded: Provide valve ends complying with ANSI B2.1.

3 Solder-Joint: Provide valve ends complying with ANSI B16.18.

4 Trim: Fabricate pressure-containing components of valve, including stems (shafts) and seats from brass or bronze materials, of standard alloy recognized in valve manufacturing industry unless otherwise specified.

5 Non-Metallic Disc: Provide non-metallic material selected for service indicated in accordance with manufacturer's published literature.

6 Renewable Seat: Design seat of valve with removable disc, and assemble valve so disc can be replaced when worn.

7 Extended Stem: Increase stem length by 2" minimum, to accommodate insulation applied over valve.

3 EXECUTION

3.1 Installation:

3.1.1 General: Install valves where required for proper operation of piping and equipment, including valves in branch lines to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward below horizontal plane.

3.1.2 Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

3.1.3 Applications Subject to Corrosion: Do not install bronze valves and valve components in direct contact with steel, unless bronze and steel are separated by dielectric insulator.

3.2 Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends or types of pipe/tube connections:

3.2.1 Tube Size 2" and Smaller: Threaded valves. Soldered-joint valves may also be used.

3.2.2 Pipe Size 2" and Smaller: Threaded valves.

3.2.3 Pipe Size 2½" and Larger: Flanged valves.

3.3 Non-Metallic Disc: Limit selection and installation of valves with non-metallic disc to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.

3.4 Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

3.5 Installation of Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction flow.

END OF SECTION

# SECTION 23 05 29 - SUPPORTS, ANCHORS, AND SEALS

1 GENERAL

1.1 Drawings and general provisions of Contract, including General Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 This section is a Division-23 Basic Materials and Methods section, and is a part of each Division-23 section making reference to or requiring supports, anchors, and seals specified herein.

1.3 Extent of supports, anchors, and seals required by this section is indicated on drawings and/or specified in other Division-23 sections.

1.4 Code Compliance: Comply with applicable codes pertaining to product materials and installation of supports, anchors, and seals.

1.5 MSS Standard Compliance:

1.5.1 Provide pipe hangers and supports of which materials, design, and manufacture comply with ANSI/MSS SP-58.

1.5.2 Select and apply pipe hangers and supports, complying with MSS SP-69.

1.5.3 Fabricate and install pipe hangers and supports, complying with MSS SP-89.

1.5.4 Terminology used in this section is defined in MSS SP-90.

1.6 UL Compliance: Provide products which are Underwriters Laboratories listed .

2 PRODUCTS

2.1 Acceptable Manufacturers: Subject to compliance with requirements, provide supports and hangers by Grinnel, Michigan Hanger Company, B-Line Systems, or approved equal.

2.2 Horizontal-Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers and supports complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper-piping systems.

2.2.1 Adjustable Steel Clevises: MSS Type 1.

2.2.2 Steel Double Bolt Pipe Clamps: MSS Type 3.

2.2.3 Adjustable Steel Band Hangers: MSS Type 7.

2.2.4 Steel Pipe Clamps: MSS Type 4.

2.2.5 Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange.

2.2.6 Single Pipe Rolls: MSS Type 41.

2.2.7 Adjustable Roller Hanger: MSS Type 43.

2.2.8 Pipe Roll Stands: MSS Type 44 or Type 47.

2.3 Vertical-Piping Clamps: Except as otherwise indicated, provide factory-fabricated vertical-piping clamps complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.

2.3.1 Two-Bolt Riser Clamps: MSS Type 8.

2.3.2 Four-Bolt Riser Clamps: MSS Type 42.

2.4 Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.

2.4.1 Steel Turnbuckles: MSS Type 13.

2.4.2 Malleable Iron Sockets: MSS Type 16.

2.5 Building Attachments: Except as otherwise indicated, provide factory-fabricated building attachments complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods.

2.5.1 Center Beam Clamps: MSS Type 21.

2.5.2 C-Clamps: MSS Type 23.

2.5.3 Malleable Beam Clamps: MSS Type 30.

2.5.4 Side Beam Brackets: MSS Type 34.

2.5.5 Concrete Inserts: MSS Type 18.

2.6 Saddles and Shields: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

2.6.1 Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.

2.6.2 Protection Saddles: MSS Type 39; use with rollers, fill interior voids with segments of insulation matching adjoining insulation.

2.7 Miscellaneous Materials:

2.7.1 Metal Framing: Provide products complying with NEMA STD ML 1.

2.7.2 Steel Plates, Shapes and Bars: Provide products complying with ANSI/ASTM A 36.

2.7.3 Cement Grout: Portland cement (ANSI/ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ANSI/ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

2.7.4 Heavy-Duty Steel Trapezes: Fabricate from steel shapes or continuous channel struts selected for loads required; weld steel in accordance with AWS standards.

3 EXECUTION

3.1 Preparation

3.1.1 Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.

3.1.2 Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, and installers of other work requiring coordination with work of this section for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.

3.2 Installation of Building Attachments:

3.2.1 Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.

3.2.2 In areas of work requiring attachments to existing concrete, use self drilling rod inserts, Phillips Drill Co., "Red-Head" or equal.

3.3 Installation of Hangers and Supports:

3.3.1 General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of

horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69 or as listed herein, whichever is most limiting. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

3.3.1.1 Horizontal steel pipe and copper tube 1-1/4" diameter and smaller: support on 6 foot centers.

3.3.1.2 Horizontal steel pipe and copper tube 1-1/2" diameter and larger: support on 10 foot centers.

3.3.1.3 Vertical steel pipe and copper tube: support at each floor.

3.3.1.4 Plastic pipe: support in accordance with manufacturer's recommendations.

3.3.1.5 Fire protection piping: support in accordance with NFPA 13.

3.3.2 Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.

3.3.3 Paint all black steel hangers with black enamel. Galvanized steel and copper clad hangers do not require paint.

3.3.4 Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

3.3.5 Provision for Movement:

3.3.5.1 Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

3.3.5.2 Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

3.3.5.3 Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 are not exceeded.

3.3.6 Insulated Piping: Comply with the following installation requirements.

3.3.6.1 Shields: Where low-compressive-strength insulation or vapor barriers are indicated, install coated protective shields.

3.3.6.2 Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.

3.3.7 Support fire protection piping independently of other piping.

3.4 Installation of Anchors:

3.4.1 Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer of loading and stresses to connected equipment.

3.4.2 Fabricate and install anchors by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.

3.4.3 Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and elbows. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.4.4 Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

3.5 Equipment Bases:

3.5.1 Concrete housekeeping bases will be provided as work of Division 3. Furnish to Contractor scaled layouts of all required bases, with dimensions of base, and location to column center lines. Furnish templates, anchor bolts, and accessories necessary for base construction.

4.6.1 Provide concrete housekeeping bases for all floor mounted equipment furnished as part of the work of Division 23. Size bases to extend minimum of 4" beyond equipment base in any direction; and 4" above finished floor elevation. Construct of reinforced concrete, roughen floor slab beneath base for bond, and provide steel rod anchors between floor and base. Locate anchor bolts using equipment manufacturer's templates. Chamfer top and edge corners.

**END OF SECTION 23 05 29**

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# SECTION 23 05 48 - VIBRATION ISOLATION

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 This section is a Division-23 Basic Mechanical Materials and Methods section, and is part of each Division-23 section making reference to vibration isolation equipment.

1.3 Extent of vibration isolation required by this section is indicated on drawings and/or specified in other Division-23 sections.

1.4 Approval Submittals: When required by other Division-23 sections, submit product data sheets for each type of vibration isolation equipment including configuration and rating data. Submit with Division-23 section using vibration isolation, not as a separate submittal. Provide calculations showing supported weight, deflection, and isolator size and type for each item of supported equipment. Submit for:

Equipment Mountings. Type EM.
Hangers. Type HA.
Bases and Frames. Type BF.

1.5 O&M Data Submittals: Submit a copy of approval submittals for each type of vibration isolation equipment. Include this data in O&M Manual.

2 PRODUCTS

2.1 General: Provide factory-fabricated products recommended by manufacturer for use in service indicated. Provide products of types and deflections indicated; provide proper selection as determined by Installer to comply with specifications and installation requirements. Provide sizes which properly fit with equipment. All metal parts installed outside shall be hot dipped galvanized after fabrication.

2.2 Acceptable Manufacturers: Subject to compliance with requirements, provide vibration isolation equipment of: Mason Industries, Keflex, Consolidated Kinetics, Vibration Mountings & Controls, Wheatley or approved equal. All vibration isolators shall be supplied by a single approved manufacturer.

2.3 Equipment Mountings:

2.3.1 Select mountings with the required deflection and fastening means. Provide steel rails or bases as required to compensate for equipment rigidity and overhang.

2.3.2 Types of equipment mountings (EM):

1 Spring Mountings (EM1): Spring isolators shall be free-standing and laterally stable without any housing. All mounts shall have leveling bolts. Spring diameter shall be not less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately one. Provide a nominal static deflection of at least 1.0". Basis of

Design: Mason Industries SLFH.

2 Spring Mountings with Housings (EM2): Spring isolators shall consist of open, stable steel springs and include vertical travel limit stops to control extension when weight is removed. The housing of the spring unit shall serve as blocking during erection of equipment. Provide a nominal static deflection of at least 1.0". All mountings used outside shall be hot dipped galvanized. Basis of Design: Mason Industries SLR.

3 Spring Mountings with Housings (EM3): Spring isolators shall consist of open, stable steel springs with neoprene inserts to limit movement between upper and lower housing on start and stop. Provide a nominal static deflection of at least 1.0". Mountings shall be specifically designed for critical areas on light-weight floors. Basis of Design: Mason Industries C.

4 Neoprene Mountings (EM4): Double deflection neoprene-in-shear mountings shall have a minimum static deflection of 0.35". All metal surfaces shall be neoprene covered. The top and bottom surfaces shall be neoprene ribbed and bolt holes shall be provided in the base. Basis of design: Mason Industries ND.

5 Pads (EM5): Waffle or ribbed pattern neoprene pads shall be fabricated from 40-50 durometer neoprene. Provide rigid steel plate and mounting angles as required. Basis of design: Mason Industries Super W.

2.4 Hangers:

2.4.1 Select hangers with the required deflection. Provide all required hanger rods and fasteners.

2.4.2 Types of hangers (HA):

1 Hangers (HA1): Vibration hangers shall contain a steel spring set in a neoprene cup manufactured with a grommet to prevent short-circuiting of the hanger rod. The cup shall contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion. Spring diameters and hanger box lower-hole sizes shall be large enough to permit the hanger rod to swing through a 30-degree arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Basis of Design: Mason Industries 30.

2 Hangers (HA2): Vibration hangers shall contain a laterally stable steel spring and 0.3" deflection neoprene or fiberglass element in series. A neoprene neck shall be provided where the hanger rod passes through the steel box supporting the isolator mount to prevent metal to metal contact. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Basis of Design: Mason Industries 30N.

3 Hangers (HA3): Double deflection neoprene-in-sheer or EPDM hangers. Units shall be complete with projected neoprene bushing to prevent steel-to-steel contact between hanger box and hanger rod. Average static deflection shall be not less than 0.4 inches. Basis of Design: Mason Industries HD.

2.5 Bases and Frames (BF):

2.5.1 Select mounting bases and frames as required for equipment dimensions, service access and fastening means. Provide all fasteners. Coordinate and provide required vibration isolators to match mounting bases and frames.

2.5.2 Types of bases and frames (BF):

1 Steel Base Frame for Floor-Mounted Equipment (BF1): Provide frames consisting of structural steel sections sized, spaced and connected to form a rigid base which will not twist, rack, deform or deflect in any manner that will negatively affect the operation of the supported equipment or the performance of the vibration-isolation mounts. Frames shall be of adequate size and plan form to support basic equipment units and motors plus any associated pipe elbow or duct elbow supports and electrical control elements or other components closely related and requiring resilient support in order to prevent vibration transfer from equipment to the building structure. Frames shall include side mounting brackets for attachment to vibration isolation floor mounts. The clearance between the underside of any frame or mounted equipment unit and the top of the building structure below shall be at least 2 inches. Basis of Design: Mason Industries WFSL.

2 Concrete Inertia Block for Floor-Mounted Equipment (BF2): Provide concrete inertia blocks formed of stone-aggregate concrete (150 lbs./cu.ft.) cast between appropriate steel reinforcing perimeter structural steel channels. Inertia block thickness shall be not less than 1/12 the longest dimension of the mounted equipment or equipment assembly. Inertia blocks shall be built to form a rigid base which will not twist, rack, deform, deflect or crack in any manner that will negatively affect the operation of the supported equipment or the performance of the vibration-isolation mounts. Inertia blocks shall be of adequate size and plan form to support basic equipment units and motors plus any associated pipe or duct elbow supports, electrical control elements or other components closely related and requiring resilient support in order to prevent vibration transfer from equipment to the building structure. Inertia blocks shall include side mounting bracket pockets for spring mounting. The clearance between the underside of any inertia block and the top of the building structure below shall be at least 2 inches. The vibration isolator supplier may furnish the structural steel perimeter frame, including reinforcing and anchor bolts. Basis of Design: Mason Industries KSL/BMK.

3 Steel Rails (BF3): Provide steel rails of channels or angles with vibration isolators as required. Basis of Design: Mason Industries, RND or RC.

4 Vibration Isolation Base for Rooftop Equipment (BF4): Provide aluminum vibration isolation bases that fit over roof curb and under the equipment. Provide spring isolators having a 1" minimum static deflection, resilient snubbers for wind resistance, closed cell weather seal at top and bottom, and EDPM flexible connection around entire perimeter. The unit shall provide a water-tight system. Basis of Design: Mason Industries CMAB.

5 Vibration Isolation Curb for Rooftop Equipment (BF5): Provide steel spring isolation curb with cadmium or zinc electroplated steel springs on ¼" thick neoprene pads to support the upper frame. The upper frame must provide continuous support for the equipment and must be held captive by ¼" thick neoprene snubber bushings.

Minimum spring deflection is 1½" 2½". Provide galvanized steel counter-flashing and EPDM bellows for the corners. Provide access covers for all springs. The entire assembly shall be waterproof. Curbs shall be a minimum of 12" high and shall include 2" thick insulation. Provide curbs designed to accommodate for roof pitch so that equipment is set level.

Provide perimeter angle and cross members with two layers of e" waterproof sheetrock at the floating member of the curb. Stagger sheetrock joints. Sheetrock must completely surround all ducts and shall be caulked. Where the mechanical arrangement prevents attaching to the floating member, the barrier shall be attached as high as possible on the fixed curb with 1" thick closed cell neoprene flexible seals around the ducts. A 4" layer of 1.5 pcf fiberglass shall cover the entire solid roof surface under the unit. Basis of Design: Mason Industries RSC-dB.

3 EXECUTION

3.1 Install vibration isolation devices for the duty indicated and for ease of inspection, adjustment, and proper operation. Install in accordance with the manufacturer's written instructions and coordinate with shop drawings of supported equipment.

3.2 All connections to fixtures and equipment shown on the drawings shall be considered diagrammatic unless otherwise indicated by detail. The actual connections shall be made to fully suit the requirements of each case and adequately provide for expansion and servicing.

3.3 Piping, ductwork and conduit shall not be suspended from one another or physically contact one another. Vibrating systems shall be kept free from non-vibrating systems.

3.4 Equipment Mountings:

3.4.1 Unless otherwise shown or specified, all floor-mounted equipment shall be set on housekeeping equipment bases. Refer to Division-23 section “Supports, Anchors, and Seals”.

3.4.2 No equipment unit shall bear directly on vibration isolators unless its own frame is suitably rigid to span between isolators, and such direct support is approved by the equipment manufacturer. All support frames shall be sufficiently stiff and rigid so as to prevent distortion and misalignment of components installed thereon.

3.4.3 Align equipment mountings for a free, plumb installation. Isolators that are binding, offset or fully compressed will not be accepted.

3.5 Hangers:

3.5.1 Position vibration isolation hangers so that hanger housing may rotate a full 360 degrees without contacting any object.

3.5.2 Install steel angles, channels, rods and fasteners to level equipment, piping or ductwork and to evenly distribute the supported weight.

3.6 Bases and Frames:

3.6.1 Unless otherwise indicated, all equipment mounted on vibration-isolated bases shall have a minimum operating clearance of 2 inches between the structural steel frame and the concrete housekeeping pad or floor beneath the equipment. The clearance space shall be checked to ensure that no construction debris has been left to short-circuit or restrict the proper operation of the vibration isolation system.

3.7 Connections of Ducts: Ducts shall be connected to fan intakes and discharges by means of flexible connectors in accordance with Division-23 section "Ductwork Accessories" so that all vibrating equipment is fully isolated.

**END OF SECTION 23 05 48**

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# SECTION 23 05 53 - MECHANICAL IDENTIFICATION

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 This section is a Division-23 Basic Mechanical Materials and Methods section, and is part of each Division-21, 22, and 23 section making reference to or requiring identification devices specified herein.

1.3 Extent of mechanical identification work required by this section is indicated on drawings and/or specified in other Division-21, 22, and 23 sections.

1.4 Refer to Division-26 sections for identification requirements of electrical work; not work of this section. Refer to other Division-23 sections for identification requirements for controls; not work of this section.

1.5 Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

2 PRODUCTS

2.1 General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division-21, 22, or 23 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.2 Painted Identification Materials

2.2.1 Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 1-¼" high letters for ductwork and not less than ¾" high letters for access door signs and similar operational instructions.

2.2.2 Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.

2.2.3 Identification Paint: Standard identification enamel.

2.3 Plastic Pipe Markers

2.3.1 Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers.

2.3.1.1 Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with name as shown or specified.

2.3.1.2 Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.4 Valve Tags:

2.4.1 Brass Valve Tags: Provide 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in ¼" high letters and sequenced valve numbers ½" high, and with 5/32" hole for fastener. Provide 1-½" diameter tags, except as otherwise indicated.

2.4.2 Plastic Laminate Valve Tags: Provide manufacturer's standard 3/32" thick engraved plastic laminate valve tags, with piping system abbreviation in ¼" high letters and sequenced valve numbers ½" high, and with 5/32" hole for fastener. Provide 1-½" square black tags with white lettering, except as otherwise indicated.

2.5 Engraved Plastic-Laminate Signs:

2.5.1 General: Provide engraving stock melamine plastic laminate, in the sizes and thicknesses indicated, engraved with engraver's standard letter style a minimum of 3/4" tall and wording indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

2.5.2 Thickness: 1/16" for units up to 20 sq. in. or 8" length; 1/8” for larger units.

2.5.3 Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.5.4 Ceiling Grid Mounted Tags: White, 1/2” lettering engraved in a ¾” black background, screwed parallel to the ceiling grid.

2.6 Stamped Nameplates: Provide equipment manufacturer's standard stamped nameplates for motors, AHUs, pumps, etc.

3 EXECUTION

3.1 Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 Ductwork Identification:

3.2.1 General: Identify air supply, return, exhaust, intake and relief ductwork with stenciled signs and arrows, showing ductwork service and direction of flow, in black or white.

3.2.2 Location: In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures, and at 50' spacings along exposed runs.

3.2.3 Access Doors: Provide stenciled signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate and procedural information.

3.3 Piping System Identification:

3.3.1 General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:

3.3.1.1 Plastic pipe markers.

3.3.1.2 Stenciled markers, black or white for best contrast.

3.3.2 Locate pipe markers as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces and exterior non-concealed locations.

3.3.2.1 Near each valve and control device.

3.3.2.2 Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.

3.3.2.3 Near locations where pipes pass through walls, floors, ceilings, or enter non-accessible enclosures.

3.3.2.4 At access doors, manholes and similar access points which permit view of concealed piping.

3.3.2.5 Near major equipment items and other points of origination and termination.

3.3.2.6 Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.

3.3.2.7 On piping above removable acoustical ceilings, except omit intermediately spaced markers.

3.3.3 The following piping shall be color-coded where exposed in mechanical and electrical rooms by completely painting the piping with the indicated color. Use standard colors where exposed in finished spaces. Use standard identification methods in concealed areas.

Fire protection piping - Red

3.4 Valve Identification: Provide a permanently affixed coded valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. Coordinate code with operating instructions.

3.5 Valve Charts: Provide framed, glass covered valve charts in each mechanical room. Identify coded valve number, valve function, and valve location for each valve.

3.6 Mechanical Equipment Identification: Install engraved plastic laminate sign on a vertical surface on or near each major item of mechanical equipment and each operational device. Label shall indicate type of system and area served. Provide signs for the following general categories of equipment and operational devices:

3.6.1 Main control and operating valves, including safety devices.

3.6.2 Meters, gauges, thermometers and similar units.

3.6.3 Pumps, compressors, chillers, condensers, and similar equipment.

3.6.4 Heat exchangers, coils, evaporators, cooling towers, heat recovery units and similar equipment.

3.6.5 Fans, blowers, primary balancing dampers and VAV boxes.

3.6.6 HVAC air handlers and fan coil units.

3.6.7 Tanks and pressure vessels.

3.6.8 Air conditioning indoor and outdoor units.

3.7 Stamped Nameplates: Equipment manufacturers to provide standard stamped nameplates on all major equipment items such as motors, pumps, AHUs, etc. Where motors are hidden from view (within equipment casing, or otherwise not easily accessible, etc.), the equipment supplier shall furnish a duplicate motor data nameplate to be affixed to the equipment casing in an easily visible location, unless data is already included on the equipment nameplate.]

3.8 Adjusting and Cleaning:

3.8.1 Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

3.8.2 Cleaning: Clean face of identification devices.

**END OF SECTION 23 05 53**

# SECTION 23 05 56 - ACCESS DOORS

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 This section is a Division-23 Basic Mechanical Materials and Methods section, and is part of each Division-21, 22, and 23 section making reference to or requiring access panels specified herein.

1.3 Approval Submittals:

1.3.1 Product Data: When required by other Division-21, 22, or 23 sections, submit product data for access doors. Submit with Division-21, 22, or 23 section using access doors, not as a separate submittal. Include rating data.

1.4 O&M Data Submittals: Submit a copy of approval submittal. Include this data in O&M Manuals.

2 PRODUCTS

2.1 Acceptable Manufacturers: Subject to compliance with requirements, provide access doors by Acudor, Milcor, Jay R. Smith, Zurn, BOICO, Elmdor, or approved equal.

2.2 General: Where floors, walls and ceilings must be penetrated for access to mechanical work, provide types of access doors indicated. Furnish sizes indicated or, where not otherwise indicated, furnish adequate size for intended and necessary access. Furnish manufacturer's complete units, of type recommended for application in indicated substrate construction, in each case, complete with anchorages and hardware.

2.3 Access Door Construction: Except as otherwise indicated, fabricate wall/ceiling door units of welded steel construction with welds ground smooth; 16-gauge frames and 14-gauge flush panel doors; 175° swing with concealed spring hinges; flush screw-driver-operated cam locks; factory-applied rust-inhibitive prime-coat paint finish.

2.4 Locks: Where indicated, provide flat pass key type 5-pin or 5-disc type cylinder locks, individually keyed unless otherwise indicated, 2 keys.

2.5 Locks: Provide Folger Adams or approved equal Model 415-6 high security deadlock six lever Number 12. All access doors shall be keyed the same throughout. Coordinate with the General Contractor.

2.6 Fire Rated Access Doors: Where required furnish with 20-gauge insulated sandwich panel, automatic closing mechanism, cylinder type lock (self-latching with inside release mechanism), and continuous concealed steel hinge pin. Access doors shall carry the UL 1-½ hour "B" label.

2.7 Insulated Access Doors: Provide 1.0” double wall insulated, hinged access doors. Provide

20 gauge satin coat steel door panels with 0.060" extruded aluminum door panel frames and 0.080" extruded aluminum flanged frame. Provide 0.75 PCF fiberglass insulation sandwiched between inner and outer panel. Provide extruded EDPM or closed cell neoprene draft seal gasket, zinc plated steel continuous hinge. Provide dual acting compression lever type handles, operable from either side of the door. Provide 2 handles for doors 48" tall or less. Provide 3 handles for doors over 48" tall.

## 3 EXECUTION

3.1 Access doors shall be installed to operate and service all mechanical equipment including valves, dampers, duct access panels, and other items requiring maintenance that are concealed above or behind finished construction. Access doors shall be installed in walls, chase and floors as necessary, but are not required in accessible suspended ceiling systems. Access doors shall have factory applied protective phosphate coating and baked enamel primer suitable for field painting.

3.2 Access doors shall be installed by the Division installing the substrate construction. However, responsibility for furnishing and determining location of access doors is part of this Division's work. The style of access door shall be suitable for construction into which installed.

3.3 Access doors shall be sized and located as required to provide proper maintenance and service access in accordance with the manufacturer's recommendations and code authority requirements for all devices and equipment.

END OF SECTION

# SECTION 23 05 90 - START-UP REQUIREMENTS FOR HEATING, VENTILATING, & AIR CONDITIONING (HVAC) SYSTEMS

1 GENERAL

1.1 Intent: It is the intent of this section to require that the startup requirements and report noted herein be performed prior to starting TAB work on each system. Work can be phased with permission of the Engineer.

1.2 Coordination:

1.2.1 The Contractor shall furnish to the TAB Contractor a complete set of plans, specifications, addenda, shop drawings, equipment performance data sheets, change orders, etc. as requested by the TAB Contractor.

1.2.2 The Contractor shall participate in a TAB coordination meeting to discuss interface requirements with the TAB Contractor and to establish a schedule for TAB work prior to start of TAB work.

1.3 Test Reports and Verification Submittals:

1.3.1 Submit Startup Report as described herein for each system. Attach Factory Startup Report for equipment as required by other Division-23 sections.

2 PRODUCTS: None

3 EXECUTION:

3.1 The TAB work shall not commence until the Engineer has received written notice from the Contractor that HVAC systems are 100% complete and are fully operational. Submit Startup Report as described herein.

3.2 The Contractor shall place all HVAC systems and equipment into complete operation during each working day of TAB work.

3.3 The Contractor shall provide access to HVAC systems and equipment by supplying ladders and/or scaffolding, and opening access panels and equipment room doors.

3.4 The TAB Contractor will provide to the Contractor TAB punch lists of non-complying HVAC work as they are discovered. The Contractor shall replace or repair non-complying work as soon as possible in order not to delay completion of TAB work.

3.5 Airside Systems: The Contractor shall provide the following information to the Engineer to substantiate proper start-up and preliminary adjustments of air handler units, belt driven fans, and duct systems.

3.5.1 Verify that air grilles (supply, return, exhaust, transfer, outdoor, etc.) are installed and connected to the duct system.

3.5.2 Verify that duct systems are clean of debris.

3.5.3 Verify that ducts attached with flexible connectors are aligned within ½" and have a uniform gap between ducts of 1"-1.5". Flexible connectors shall not leak and shall be insulated.

3.5.4 Verify that filters are clean and filter spacers are installed.

3.5.5 Verify that balancing dampers at grilles and branch ducts are operational and are fully opened.

3.5.6 Verify that fire and smoke dampers are correctly installed and are fully opened.

3.5.7 Verify that fan discharges are appropriate for the outlet ductwork with regards to the "system effect" per AMCA Publication 201. Inappropriate fan discharges will not be accepted.

3.5.8 Verify proper fan rotation.

3.5.9 Verify proper belt drive alignment.

3.5.10 Verify fan motor overload elements are correctly sized.

3.5.11 Adjust fan sheave until CFM is at or above design CFM. Provide additional sheaves and belts as required. Verify that motor is not overloaded.

3.5.12 Verify that HVAC control systems are fully operational.

3.6 Startup Report: The Contractor shall submit the startup information required by this section to the Engineer in a typed report organized as outlined herein. The Startup Report is required to meet the written notice described herein prior to starting TAB work. TAB work will not start until the Startup Report has been submitted and approved.

END OF SECTION

# SECTION 230591 - TESTING, CLEANING, AND STERILIZATION OF PIPING SYSTEMS

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 This section is a Division-23 Basic Mechanical Materials and Methods section, and is part of each Division-21, 22, and 23 section making reference to or requiring the testing and other procedures specified herein.

1.3 Notify the Architect/Engineer when system tests are ready to be witnessed at least 24 hours prior to the test.

1.4 All materials, test equipment, and devices required for cleaning, testing, sterilizing or purging shall be provided by the Contractor.

2 PRESSURE TESTS

2.1 General: Provide temporary equipment for testing, including pump and gauges. Test piping systems before insulation is installed wherever feasible, and remove control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with indicated medium and pressurize for indicated pressure and time.

2.2 Required test period is four hours.

2.3 No piping, fixtures, or equipment shall be concealed or covered until they have been tested. The contractor shall apply each test and ensure that it is satisfactory for the period specified before calling the Architect/Engineer to observe the test. Test shall be repeated upon request to the satisfaction of those making the inspection.

2.4 Observe each test section for leakage at the end of the test period. Test fails if leakage is observed or if pressure drop exceeds 5% of the test pressure.

2.5 Check of systems during application of test pressures should include visual check for water leakage and soap bubble or similar check for air and nitrogen leakage.

2.6 During heating and cooling cycles, linear expansion shall be checked at all elbows and expansion joints for proper clearance.

2.7 Repair piping systems sections which fail required piping test. Disassemble and re-install using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

2.8 Pressure Test Requirements:

2.8.1 Soil, Waste, Vent Test all piping within the building with a 10 foot head of water. Test piping in sections so that all joints are tested. Provide test tees as required.

2.8.2 Domestic Water: Perform hydrostatic test on all piping within the building at twice the normal static pressure at service point, but not less than 100 psig. Once tested, flush out piping and leave under pressure of the supply main or 40 psig for the balance of the construction period.

2.8.3 Fire Sprinkler System: Perform hydrostatic test at 200 psig.

2.8.4 Medical Gases, Air, and Medical Vacuum: Test in accordance with NFPA 99 and related Division 15 sections.

3 CLEANING AND STERILIZATION

3.1 General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems with clean water or blowdown with air before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.

3.2 Flush and drain all water systems at least three times. Reverse flush systems from smallest piping to largest piping. Replace startup strainers with operating strainers.

3.3 Sterilization of Domestic Water Systems:

3.3.1 Prerequisites: All hot and cold water piping installed (complete), all fixtures connected, system flushed out, and system filled with water.

3.3.2 The shut off valve at the point of connection shall be closed, all fixture outlets opened slightly, and a sterilizing solution shall be introduced at a manifold connection installed by the Contractor at the point of connection.

3.3.3 The solution shall contain 50 parts per million of available chlorine. The chlorinating material shall be either liquid chlorine or calcium hypochlorite. The solution shall be allowed to stand in the system for at least eight hours after which the entire system shall be flushed.

3.3.4 After final flushing, all aerators shall be removed, cleaned, and reinstalled. After final flush the residual chlorine shall not exceed 0.2 parts per million.

3.3.5 The Architect/Engineer shall be notified 24 hours prior to the procedure so that it can be witnessed.

3.3.6 Provide sampling and certified report by an independent testing lab. Provide written Health Department approval of disinfection samples.

3.4 Medical Gas: Purge all medical gas systems in accordance with NFPA 99.

END OF SECTION

# SECTION 23 05 93 - TESTING AND BALANCING OF MECHANICAL SYSTEMS

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section. Division-23 Basic Mechanical Materials Sections apply to work of this section.

1.2 Description of Work:

1.2.1 Extent of testing, adjusting, and balancing work (TAB) is indicated by requirements of this section, and also by drawings and schedules, and is defined to include, but is not necessarily limited to, air distribution systems, hydronic distribution systems and associated equipment and apparatus of mechanical work. The work consists of setting speed and volume (flow) adjusting facilities provided for systems, recording data, conducting tests, preparing and submitting reports, and recommending modifications to work as required.

1.2.2 Coordination: Coordinate with the General Contractor and Mechanical Contractor responsible for the HVAC system installation as required to complete the TAB work.

1.3 The intent of this specification is to balance HVAC systems within the tolerances listed, maintaining the pressure relationships indicated, with a minimum of noise.

1.3.1 Airflow Tolerances:

1.3.1.1 Air Handling: The supply air, return air and outdoor air quantities shall be balanced within ±5% of design values.

1.3.1.2 Exhaust Fans: The exhaust fan quantities shall be set as required to maintain the design exhaust terminal flows within ±5% of design values. If no exhaust terminals exist, exhaust fan air quantities shall be balanced within ±10% of design values.

1.3.1.3 Ceiling Diffusers, Supply Registers, Return and Exhaust Inlets: Balance to an air quantity within ±10% of the design values.

1.3.2 Temperature Tolerances:

1.3.2.1 Air Handling Temperatures: The controlled temperatures at AHUs shall be verified to be under control within ±1ºF of design values.

1.3.2.2 Room Temperatures: Balance systems and controls within ±2ºF of indicated settings.

1.3.3 Pressure Relationships: Where code or design indicates a specific pressure relationship, the pressure relationship shall take precedence over airflow tolerances. Airflow tolerances may need to be held tighter than allowed tolerances to meet pressure relationships. Demonstrate the existence of positive or negative pressure to Engineer and authority having jurisdiction by making direct measurements of room relative pressure and/or flow direction.

1.4 Quality Assurance: The TAB Contractor shall be certified as follows:

1.4.1 Tester: A firm certified by National Environmental Balancing Bureau (NEBB) in those

testing and balancing disciplines required for this project, who is not the Installer of the systems to be tested and is otherwise independent of the project. Comply with NEBB's "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems" as applicable to this work.

1.4.2 Tester: A firm certified by Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project. AABC-certified firms are independent by definition. Comply with AABC's Manual MN-1 "AABC National Standards", as applicable to this work.

1.4.3 Industry Standards: Comply with American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to measurements, instruments and testing, adjusting and balancing, except as otherwise indicated.

1.5 Job Conditions:

1.5.1 Do not proceed with testing, adjusting, and balancing work until HVAC work (including Controls) has been completed and is operable. Ensure that there is no residual work still to be completed.

1.5.2 Do not proceed until work scheduled for testing, adjusting, and balancing is clean and free from debris, dirt and discarded building materials.

1.5.3 Do not proceed until architectural work that would affect balancing (walls, ceiling, windows, doors) have been installed.

1.5.4 Testing may proceed system by system, but each HVAC system must be complete as describe herein.

1.5.5 The mechanical contractor shall make any changes in pulleys, belts, and dampers, and/or add dampers as required for correct balancing.

1.6 Approval Submittals

1.6.1 Submit the name of the proposed test and balance company for the Engineer's approval within thirty (30) days after awarding of contract.

1.7 Test Reports and Verification Submittals:

1.7.1 Submit four (4) copies of the dated test and balance report upon completion of TAB work. The report shall include a list of instruments used for the work. The report shall be signed by the supervisor who performed the TAB work.

2 PRODUCTS

2.1 Patching Materials: Except as otherwise indicated, use same products as used by original Installer for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes.

2.2 Test Instruments: Utilize test instruments and equipment of the type, precision, and capacity as recommended in the referenced standard. All instruments shall be in good condition and shall have been calibrated within the previous six (6) months (or more

recently if required by standard).

3 EXECUTION

3.1 General:

3.1.1 Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned and is operable. Do not proceed with TAB work until unsatisfactory conditions have been corrected in manner acceptable to Tester.

3.1.2 Test, adjust and balance environmental systems and components, as indicated, in accordance with procedures outlined in applicable standards, and as modified or detailed herein.

3.1.3 Test, adjust and balance systems during summer season for air conditioning systems and during winter season for heating systems, including at least a period of operation at outside conditions within 5ºF wet bulb temperature of maximum summer design condition, and within 10ºF dry bulb temperature of minimum winter design condition. When seasonal operation does not permit measuring final temperatures, then take final temperature readings when seasonal operation does permit. The Contractor shall return for a change of seasons test at no additional cost to the Owner and submit the revised TAB report.

3.1.4 Punch List: Prepare a deficiency (punch)list for the Contractor with a copy of the Engineer that lists all items that are incorrectly installed or are functioning improperly. Provide a retest after all items are corrected.

3.1.5 Prepare TAB report of test results, including instrumentation calibration reports, in format recommended by applicable standards, modified as required to include all data listed herein.

3.1.6 Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes, in manner recommended by original Installer.

3.1.7 Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings at completion of TAB work. Provide markings with paint or other suitable permanent identification materials.

3.1.8 Include in the TAB report recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

3.1.9 Include an extended warranty of ninety (90) days after completion of test and balance work, during which time the Engineer, at his discretion, may request a recheck, or resetting of any component as listed in test report. The TAB company shall provide technicians and instruments and make any tests required by the Engineer during this time period.

3.2 Controls

3.2.1 Check all HVAC controls for proper location, calibration and sequence of operation.

3.2.2 Check operation of all controllers and controlled devices to verify proper action and

direction. Check the operation of all interlocks.

3.2.3 Check all motorized damper motors for leakage when in closed position. If leakage is more that 5%, mechanical contractor shall reset damper linkages.

3.2.4 Check all control valves for complete closure and correct action under all operating conditions.

3.3 Air Balancing

3.3.1 Leakage tests on ductwork must have been completed before air balancing.

3.3.2 Set dampers, volume controls and fan speeds to obtain specified air delivery with minimum noise level. Rebalance as required to accomplish this. Simulate fully loaded filters during test.

3.3.3 Set grille deflections as noted on plans. Modify deflections if required to eliminate drafts or objectionable air movement.

3.3.4 Record air terminal velocity after completion of balance work.

3.3.5 Record final grille and register deflection settings if different from that specified on contract drawings.

3.3.6 Record all fan speeds.

3.4 Data Collection:

3.4.1 In addition to the data required for any specified performance tests, measure and record the temperatures, pressures, flow rates, and nameplate data for all components listed herein.

3.4.2 It is the intent of this section to record data on balanced systems, under normal operating or design conditions.

3.4.3 Temperatures:

1. Outside dry and wet bulb temperatures.
2. Dry bulb temperature in each room and at least one wet bulb temperature in each zone.
3. Refrigerant liquid and suction temperatures.
4. Inlet and outlet temperature of each heat exchange device - both fluids.

3.4.4 Pressures:

1. Suction and discharge static pressure of each fan.
2. Suction and discharge pressure of each pump.
3. Each refrigerant suction and discharge pressure.

3.4.5 Flow rates:

1. Flow rate through each fan.

3. Flow rate through each coil or heat exchange device.

3.4.6 Nameplate Data:

1. Complete nameplate data for all equipment.

2. Motor data to include horsepower, phase, voltage, RPM, full load nameplate current, fuse rating in disconnect switch, number or manufacturer's size designation, and ampere rating of overcurrent and low voltage protection devices in starters.

**END OF SECTION 23 05 93**

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# SECTION 23 07 13 - EXTERIOR INSULATION FOR DUCTWORK

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.3 Approval Submittals:

1.3.1 Product Data: Submit producer's data sheets and installation instructions on each insulation system including insulation, coverings, adhesives, sealers, protective finishes, and other material recommended by the manufacturer for applications indicated. Submit for:

Rigid duct insulation
Flexible duct insulation

1.4 O&M Data Submittals: Submit a copy of all approval submittals. Include in O&M Manual.

2 PRODUCTS

2.1 Acceptable Manufacturers: Subject to compliance with requirements, provide insulation products by Knauf, Owens-Corning, Johns Manville, Certainteed.

2.2 Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, coverings, sealers, mastic, and adhesive) with a flame spread rating of 25 or less, and a smoke-developed rating of 50 or less as tested by ANSI/ASTM 84.

2.3 Rigid Fiberglass Insulation Board: ASTM C612, Class 1 (non load bearing). Boards shall be 3 pcf density with UL rated aluminum foil vapor barrier (FSK).

2.4 Flexible Fiberglass Insulation: ASTM C553, Type I, Class B-3 (temperature less than 350ºF). Duct wrap shall be 1 pcf density with UL rated aluminum foil vapor barrier (FSK).

2.5 General Purpose Mastic: Benjamin Foster 35-00 Series, Insulcoustic VIAC Mastic, Childers CP-10, or approved equal. The final selection of this product for the specific application indicated is the responsibility of the insulation supplier. The insulation system must meet the specified application.

2.6 Vapor Barrier Sealant: Benjamin Foster 30-35, Insulcoustic IC-501, 3M EC-1378, Childers CP-30, or approved equal. Provide "Low Odor" type. The final selection of this product for the specific application indicated is the responsibility of the insulation supplier. The insulation system must meet the specified application.

2.7 Adhesive: Benjamin Foster 85-20, Insulcoustic IC-205, 3M EC-35, Childers CP-82, Childers CP-89, or approved equal. The final selection of this product for the specific application indicated is the responsibility of the insulation supplier. The insulation system must meet the specified application.

2.8 Fiber-Glas Mesh: 10x10 Mesh. Foster Mastafab or equal.

3 EXECUTION

3.1 Insulate all supply, return and outdoor air ductwork exposed in mechanical rooms, mezzanines, fan lofts or in any finished spaces with 1½" thick rigid fiberglass insulation with vapor barrier.

3.2 Installation of Rigid Insulation:

3.2.1 Clean and dry ductwork prior to insulating. Butt insulation firmly together to ensure complete and tight fit over surfaces to be covered. Install insulation materials with smooth and even surfaces. Maintain integrity of aluminum vapor barrier wherever possible. Extend insulation without interruption through walls, floors and similar ductwork penetrations except where otherwise indicated.

3.2.2 Install with facing to the outside with a maximum of 25% compression. Butt all insulation joints firmly together. Longitudinal seam of the vapor retarder must be overlapped a minimum of 2". Staples shall be outward clinch and placed approximately 6" on center. All penetrations, joints, seams, and damage to the facing shall be sealed with glass fabric and mastic prior to system startup. For rectangular ducts over 24" wide, secure the insulation to the bottom of the duct with mechanical fasteners spaced on 12" centers to reduce sag. Do not overcompress the insulation with the retainer. Larger ducts shall be secured with fastners on 12-inch centers and 3 inches from all edges.

3.2.3 Apply open mesh glass fabric embedded in vapor barrier mastic. Then apply a second coat of general purpose mastic with aluminum grey color. This finish shall be complete over all rigid insulation.

3.3 Insulate all supply, return and outdoor air ductwork concealed above ceilings, in chases, or elsewhere, and the backs of all ceiling supply outlets with 2" thick fiberglass blanket insulation with vapor barrier.

3.4 Installation of Flexible Insulation:

3.4.1 Insulate round elbows and fittings with wrap such that thickness is equal to adjoining duct covering. Clean and dry ductwork prior to insulating.

3.4.2 Adhere insulation to duct with 50 percent coverage using approved insulation adhesive applied in 6-inch wide swaths with 6-inch spaces between swaths. Additionally secure insulation with perforated pins and Tuff-Bond or by self-sticking pins with a 3/8" self-tapping screw. Space on 12-inch centers and 3 inches from all edges. Ducts up through 24" wide only require one row of pins. Ducts over 24" wide shall have pins spaced as described herein.

3.4.3 Lap all joints 2 inches and seal joints with 4-inch wide strips of open mesh glass fabric embedded in two coats of general purpose mastic.

3.4.4 Seal all punctures and breaks in aluminum vapor barrier with open mesh glass fabric and vapor barrier sealant.

**END OF SECTION 23 07 13**

# SECTION 23 07 16 - INSULATION FOR HVAC EQUIPMENT AND PIPING

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-23 Basic Mechanical Materials and Methods Sections apply to work of this section.

1.3 Approval Submittals:

1.3.1 Product Data: Submit producer's data sheets and installation instructions on each insulation system including insulation, coverings, adhesives, sealers, protective finishes, and other material recommended by the manufacturer for applications indicated. Submit for:

Flexible unicellular piping insulation

1.4 O&M Data Submittals: Submit a copy of all approval submittals. Include in O&M Manual.

2 PRODUCTS

2.1 Acceptable Manufacturers: Subject to compliance with requirements, provide insulation products by Armstrong, Johns Manville, Knauf, Owens Corning, Pittsburgh Corning, U.S. Rubber, or approved equal. All products shall be asbestos-free.

2.2 Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics, and adhesive) with a flame-spread rating of 25 or less, and a smoke-developed rating of 50 or less, as tested by ANSI/ASTM E84.

2.3 Pipe Insulation Materials:

2.3.1 Flexible Unicellular Pipe Insulation: ASTM C534, Type I. (Tubular, suitable for use to 200ºF.)

2.3.2 Staples, Bands, Wires, and Cement: As recommended by the insulation manufacturer for applications indicated.

2.3.3 Adhesives, Sealers, Protective Finishes: Products recommended by the insulation manufacturer for the application indicated.

3 EXECUTION

3.1 General:

3.1.1 Install thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

3.1.2 Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

3.1.3 Maintain integrity of vapor-barrier on insulation and protect it to prevent puncture and other damage. Label all insulation "ASBESTOS FREE".

3.1.4 Do not apply insulation to surfaces while they are hot or wet.

3.1.5 Do not install insulation until systems have been checked and found free of leaks. Surfaces shall be clean and dry before attempting to apply insulation. A professional insulator with adequate experience and ability shall install insulation.

3.1.6 Do not install insulation on pipe systems until acceptance tests have been completed except for flexible unicellular insulation. Do not install insulation until the building is "dried-in".

3.2 Flexible Unicellular Pipe Insulation:

3.2.1 Insulate the following piping systems:

3.2.1.1 Condensate drains from air conditioning units - ½" thick.

3.2.1.2 Refrigerant piping - ¾" thick.

3.2.2 Apply insulation in accordance with the manufacturer's recommendations and instructions. Mitre cut insulation to fit pipe fittings. Use approved cement to seal all joints and ends in the insulation.

3.2.3 Insulation outside the building shall be protected by a smooth 0.016" thickness aluminum jacket secured with aluminum bands on 12" centers.

**END OF SECTION 23 07 16**

## SECTION 23 08 00 - HVAC SYSTEM COMMISSIONING

1 GENERAL

1.1 Intent: This section describes the work performed by the HVAC Commissioning Authority and the supporting work required by the Contractor. The Commissioning Authority will be provided by the Owner. selected by the owner and assigned to the Contractor. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 Intent of Commissioning Process:

1.2.1 Verify operation and functional performance of HVAC systems for compliance with "Design Intent". "Design Intent" is used to indicate the detailed requirements for the HVAC system, comprised of:

1.2.1.1 Design criteria and assumptions

1.2.1.2 HVAC system description and contract documentation

1.2.1.3 Intended methods of system operation and maintenance

1.2.2 Document HVAC tests and inspections.

1.2.3 Verify application of operation and maintenance manuals, as-built (record) documents, spare parts listing, special tools listing, and other items as may be specified herein for support of HVAC systems and equipment.

1.2.4 Coordinate and direct training to personnel for operation and maintenance of HVAC equipment and systems.

1.3 Contractor Scope of Work: Contractor shall perform all testing and demonstrate system operation to support the Commissioning Authority. Furnish labor and materials to support complete HVAC commissioning as specified herein. Support interim commissioning of HVAC systems during initial season operation and follow-up commissioning of required HVAC systems during additional season operation.

1.4 Quality Assurance:

1.4.1 Reference: ASHRAE Guideline 1-1989, *Guideline for Commissioning of HVAC Systems*.

1.5 Documentation:

1.5.1 Provide the following to the Commissioning Authority:

1.5.1.1 Project plans and specification (contract documents), authorized revisions, approved HVAC shop drawings and submittals, Startup Reports, Test and Balance Reports, factory start-up and certification reports, etc.

1.5.1.2 Records of required code authority inspections, documentation sign-offs, etc.

1.6 Submittals:

1.6.1 HVAC Commissioning Authority will provide the following to the Contractor prior to starting the commissioning process.

1.6.1.1 Commissioning Plan consisting of specific equipment and system checklists.

1.6.1.2 Training Plan outlining required training and documentation.

1.6.2 Contractor shall submit the following prior to starting the commissioning process.

1.6.2.1 O & M Manuals.

1.6.2.2 Startup Reports per Division-23 section 23 05 90.

1.6.2.3 Test and Balance Report per Division-23 section 23 05 93.

1.6.2.4 List of tools and spare parts required by other Division-23 sections.

1.7 Responsibilities:

1.7.1 Contractor:

1.7.1.1 Contractor shall verify completeness of the building envelope, perimeter and interior items which effect proper operation and control of HVAC equipment and systems.

1.7.1.2 The Contractor shall assure participation and cooperation of trade subcontractors (electrical, Test and Balance, controls/energy management, IAQ, and HVAC) under his contract as required for the commissioning process.

1.7.1.3 The Contractor shall secure the services of a professional video service to record all training sessions provided by the subcontractors. All training sessions shall be professionally videotaped and two copies provided to the Owner.

1.7.2 Subcontractors:

1.7.2.1 The subcontractors shall be responsible for providing labor, material, equipment, etc., required within the scope of their specialty to facilitate the commissioning process. The subcontractors shall perform tests and verification procedures required by the commissioning process when requested by the Commissioning Authority and directed by the Contractor.

1.7.3 Owner:

1.7.3.1 Owner will schedule their personnel to participate in the HVAC Commissioning process. This may include building security personnel, HVAC operation personnel and maintenance personnel. Personnel operating and maintaining equipment and systems will attend training sessions., factory schools, and educational institutions where indicated.

1.7.3.2 Owner shall advise HVAC Commissioning Authority regarding changes in building occupancy and/or usage.

2 PRODUCTS

2.1 Instrumentation: Instrumentation shall be provided by agency performing prior tests. Instruments shall be operated by the individual agency requested by the HVAC Commissioning Authority, as specified elsewhere herein.

3 EXECUTION

3.1 General: The HVAC Commissioning Authority will actively participate in construction phase of the project to assure compliance with HVAC Commissioning requirements.

3.2 Procedure:

3.3 The Contractor and designated subcontractors shall attend a pre-commissioning meeting and establish requirements for HVAC Commissioning. The meeting shall outline:

3.3.1 Responsibility of each trade affected by HVAC Commissioning, as required by appropriate section of the specification and indicated on equipment and system checklists provided by the Commissioning Authority.

3.3.2 Requirements for documentation as listed elsewhere herein.

3.3.3 Requirements for documentation of HVAC test and inspections required by code authorities.

3.3.4 Requirements for the HVAC Commissioning program during specified operational seasons, part and full loads and as further delineated in Paragraph 3.4.

3.3.5 Format for training program for operation and maintenance personnel.

3.4 HVAC Commissioning:

3.4.1 To assist in the commissioning process, Operation and Maintenance manuals shall be completed and turned over to the Commissioning Authority as soon as possible during the course of the project, but in no case later than one month prior to the initial date scheduled for substantial completion.

3.4.2 The Commissioning Authority will develop and submit a specific start-up, check-out and sign-off form for every piece of major equipment and system, as well as other equipment hereinafter listed. These forms and lists do not necessarily indicate all the activities, tests and procedures which will be required for the commissioning and start-up of each piece of equipment and system.

3.4.3 The Contractor shall develop a work plan to demonstrate system and equipment operation. Systems shall be operated under actual or simulated full load conditions. Identify the operating conditions in the work plan. Where appropriate, systems shall be operated, tested, and started up, to assure operation for each of their seasonal or different characteristics, (for example heating and cooling).

3.4.4 After all components and every system has been completely commissioned, provide a 2-week, 24-hour per day fully functional automatic operation period of all systems simultaneously. This shall be successfully concluded before systems are accepted by the Owner.

3.4.5 Execute the final approved start-up and commissioning plan.

3.4.6 HVAC Commissioning shall begin only after HVAC equipment and systems, along with related equipment, systems, structures and areas are complete. Systems may be commissioned individually if requested by the Contractor and approved by the Commissioning Authority.

3.4.6.1 Verify Test and Balance readings, such as:

3.4.6.1.1 Supply and return air volumes

3.4.6.1.2 Fan performance

3.4.6.1.3 Branch duct readings

3.4.6.2 Verify calibration of thermostats and related controls, such as:

3.4.6.2.1 Fan coil units

3.4.6.2.2 Damper settings

3.4.6.3 Verify readings of remote data and control systems (Energy Management Control System), such as:

3.4.6.3.1 Temperatures

3.4.6.3.2 Air Flows

3.4.6.3.3 Damper positions

3.4.6.3.4 Differential pressures

3.4.6.4 Verify that the total HVAC system is performing to provide conditions as outlined in "Design Intent", for seasonal full load and part load conditions, as follows:

3.4.6.4.1 Temperature

3.4.6.4.2 Humidity

3.4.6.4.3 Air changes

3.4.6.4.4 Air movement

3.4.6.4.5 Air quality

3.4.6.4.6 Zone control

3.4.6.4.7 Energy Management

3.4.6.4.8 Pressurization

3.4.6.4.9 Control response

3.5 HVAC Start-Up Procedures:

3.5.1 Prior to start-up of any air handling equipment, the Commissioning Authority and the Contractor shall inspect the installation and verify that:

3.5.1.1 Ductwork is complete, clean and pressure-tested per specifications.

3.5.1.2 Prefilters and final filters are installed by the Contractor per design specifications; prefilters are to be replaced by the Contractor as required during this start-up period. The final filters shall be replaced by the Contractor any time that the static pressure drop across the filter exceeds 1.0". The filters installed shall meet design specifications and shall be dated with a felt-tip marker upon installation.

3.5.1.3 All electrical work is complete.

3.5.1.4 Safety devices are in place and operational.

3.5.1.5 Energy Management controls are installed and have been verified to be operational by the controls contractor.

3.5.1.6 All piping has been installed and insulated per specifications.

3.5.2 Prior to Occupancy:

3.5.2.1 No less than two weeks prior to substantial completion, the HVAC system for the space to be occupied shall be approved by the Commissioning Authority to be operational under the start-up procedures and shall be set up by the Contractor to operate continuously on a 24-hour basis. The following requirements shall be established by the Commissioning Authority and adhered by to the contractors during this period:

3.5.2.1.1 The Energy Management Control System is completely installed, and the EMCS Contractor has submitted a statement verifying that the system is complete and operational.

3.5.2.1.2 The HVAC air side and water systems shall be balanced at design levels by the Contractor, all systems and devices shall be operating according to specifications, and the Contractor's TAB report has been submitted to an approved by the HVAC system Design Engineer.

3.5.2.1.3 Outdoor air shall be set at maximum design levels and maintained at those levels continuously during the two-week ventilation period.

3.5.2.1.4 All exhaust systems are operational and functioning according to design CFM and specifications.

3.5.2.1.5 All electric heaters and hydronic reheat systems are installed and operational.

3.5.2.1.6 Prefilters shall continue to be replaced by the Contractor as required per the start-up schedule. The final filter shall be replaced by the Contractor at any time that the static pressure drop across the filter exceeds 1.0".

3.5.2.1.7 All interior spaces are secured with doors and windows normally closed.

3.5.2.1.8 Interior air quality shall be maintained at 75ºF and relative humidity less than 60%.

3.5.3 At Occupancy: Following the date of final completion and prior to occupancy, the Commissioning Authority shall verify all prefilters and final filters have been replaced with new, approved, specified filters.

3.6 Scheduling of Commissioning Activities

3.6.1 The contractor shall develop a schedule of commissioning related activities. The activities to include in the schedule and their relationship are listed below, in this specification section and in other specification sections.

3.6.2 The Commissioning Schedule shall include milestones and activities listed below:

- Notice to Proceed
- Commissioning Kickoff Meeting
- Equipment Startup
- Start of Functional Testing
- Training Planning Workshop
- Owner Training Session
- Substantial Completion Inspection

**COMMISSIONING ACTIVITIES AND SCHEDULE RELATIONSHIP**

| Task | Specification Paragraph | Schedule Relationship |
|---|---|---|
| Contractor to provide current Contract Documents and changes to CxA | 1.5.1.1 | Upon contractor's **Notice-To-Proceed** and throughout the project if changed. |
| Commissioning Schedule | | Seven days prior to **Commissioning Kickoff Meeting**. |
| Schedule Commissioning Kickoff Meeting | | Schedule **Commissioning Kickoff Meeting** within 30 days after mobilization to the site. |
| Contractor to provide Approved HVAC shop drawings and submittals to CxA | 1.5.1.1 | Within 15 days of **Engineers' Approval**. |
| Contractor to provide O & M Manuals | 1.6.2.1 & 3.4.1 | No Later than one month prior to date of scheduled **Substantial Completion Inspection**. |
| Contractor to provide Startup Reports to CxA | 1.5.1.1 & 1.6.2.2 | Within one week of **Equipment Startup**. |
| Contractor to provide Test and Balance Report to CxA | 1.5.1.1 & 1.6.2.3 | Prior to **Start of Functional Testing** |
| Contractor & CxA Pre-Start-Up Inspection | 3.5.1 | No less than three days prior to any **Equipment Startup** activity. |
| Contractor to provide Certification Reports to CxA.<br>Ductwork Pressure Test<br>DDC Statement of Completeness<br>Engineer's approval of T&B Report<br>Verification of completeness | 1.5.1.1<br><br>3.5.1.1<br>3.5.2.1.1<br>3.5.2.1.2<br>1.7.1.1 & | No later than seven days prior to **Start of Functional Testing**. |

| | | |
|---|---|---|
| | 3.4.6 | |
| Contractor shall coordinate, schedule and train Owner's personnel in accordance with Training Plan provided by CxA. | 1.7.1 | Attend **Training Planning Workshop** 30 days prior to Substantial Completion Inspection.<br>Conduct Training Session 10 days prior to Substantial Completion Inspection. |
| Contractor to provide Training and videographer | 1,6.1.2 | At **Training Session** |
| Contractor to provide a list of manufacturers recommended tools and spare parts. | 1.6.2.4 | Prior to **Training Planning Workshop** |
| Contractor to support Initial Season Commissioning Activities | 1.3 | Construction Commissioning activity |
| Contractor to support Additional Season Commissioning Activity | 1.3 | Post Construction Change of Season |
| Contractor to provide Records of Code Authority Inspections to CxA | 1.5.1.2 | Within Ten-days of **Code Inspection**. |
| Contractor to perform Equipment Prefunctional Checklist | 3.4.2 | Seven Days prior to **Equipment Startup**. |
| MC and Cntrls Contractor Demonstration | 3.4.3 | Upon receipt of **DDC Statement of Completeness** (both program and graphics) |
| Two-week Operational Test Period | 3.4.4 | Start two-week period upon successful **Functional Testing Demonstration** |

END OF SECTION

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# SECTION 23 09 23 - DIRECT DIGITAL CONTROLS

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.3 Extent of Energy Management Control And DDC Systems (EMCS/DDC) work required by this section is indicated on drawings and input/output schedules , and by requirements of this section. Control sequences are specified in Division-23 section "HVAC Sequence of Operation".

1.4 Refer to other Division-23 sections for installation of instrument wells, valve bodies and dampers in mechanical systems; not work of this section.

1.5 Refer to Division-26 sections for the following work; not work of this section. Power supply wiring for power source to power connection on controls and/or EMCS panels. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

1.6 Provide the following electrical work as work of this section, complying with requirements of Division-26 sections: Control wiring between field-installed controls, equipment, indicating devices, and EMCS/DDC panels.

1.7 Codes and Standards:

1.7.1 Electrical Standards: Provide electrical products which have been tested, listed and labeled by UL and comply with NEMA standards.

1.7.2 NEMA Compliance: Comply with NEMA standards pertaining to components and devices for electric control systems.

1.7.3 NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

1.7.4 Federal Communication Commission (FCC) as required.

1.8 Approval Submittals:

1.8.1 Product Data: Submit manufacturer's technical product data for each EMCS/DDC panel and control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials. Include installation instructions and start-up instructions. Provide technical specification data for each component and software module.

1.8.2 Shop Drawings: Submit shop drawings for the EMCS/DDC containing the following information:

1.8.2.1 Schematic flow diagram of system showing fans, pumps, coils, dampers, valves, and control devices.

1.8.2.2 Label each control device with setting or adjustable range of control.

1.8.2.3 Indicate all required electrical wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed. The point-to-point wiring diagram shall show all interconnections.

1.8.2.4 Provide details of faces of EMCS/DDC panels, including controls instruments and labeling.

1.8.2.5 Include written description of sequence of operation.

1.9 Test Reports and Verification Submittals:

1.9.1 Submit system verification letter from manufacturers representative stating that all HVAC controls have been checked, calibrated, started up and verified for proper operation. State that the Owner training has been completed and provide a roster of attendees.

1.10 O&M Data Submittals:

1.10.1 Maintenance Data: Submit maintenance instructions and spare parts lists for each type of control device. Include that type data, and a copy of all approval submittals in O&M Manual.

1.10.2 System Manual: In addition to the maintenance data requirements, provide an EMCS/DDC Owner's Manual in a separate binder specifically for this project. This manual shall provide a description of the information flow to and from panels and devices and shall describe the overall communications network. The manual shall also include operating instructions, block diagrams, schematics, schedules, and system descriptions. Instruct Owner's personnel with this manual during the required training periods.

1.10.3 Software: Submit a copy of all software.

1.10.4 Service: Submit name, address, and telephone number of company that will provide service and training for the system.

2 PRODUCTS

2.1 Acceptable Manufacturers: Subject to compliance with requirements, provide EMCS/DDC control systems of one of the following:

Alerton
Siebe
Honeywell, Inc.
Johnson Controls, Inc.
Siemens

2.2 General: Provide EMCS/DDC control products in sizes and capacities indicated, consisting of valves, dampers, sensors, controllers and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard control system components as indicated by published product information, designed and constructed as recommended by manufacturer. Provide an EMCS/DDC controls system with the following

functional and construction features as indicated.

2.3 Quality Assurance:

2.3.1 Provide equipment of firms regularly engaged in manufacture of EMCS/DDC equipment, of types required, whose products have been in satisfactory use in similar service for not less than three years. Provide evidence that software has been in use satisfactorily for at least one year.

2.3.2 Contractor shall have at least three years experience in the installation and servicing of EMCS/DDC equipment similar to that being installed. Contractor shall have an office within 100 miles of the project and shall maintain a remote terminal capable of communication with the EMCS/DDC during the year warranty period.

2.4 Control Valves: Provide factory-fabricated electric control valves of type, body material and pressure class indicated. Where type or body material is not indicated, provided selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature rating of piping system. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve. Except as otherwise indicated, provide valves which mate and match material of connecting piping. Equip control valves with control valve motors with proper shutoff ratings for each individual application.

2.4.1 Water Service Valves: Equal percentage characteristics with rangeability of 50 to 1, and maximum full flow pressure drop of 10 feet head unless otherwise indicated. Two-way valves shall be suitable for dead-end service.

2.4.2 Steam Service Valves: Linear characteristics with rangeability 30 to 1, and maximum full flow pressure drop of 80% of inlet pressure for low pressure systems, and 42% for high pressure systems.

2.4.3 Single-Seated Valves: Cage type trim, providing seating and guiding surfaces for plug on “top and bottom” guided plugs.

2.4.4 Double-Seated Vales: Balanced plug-type, with cage type trim providing seating and guiding surfaces for plugs on “top and bottom” guided plugs.

2.4.5 Valve Trim and Stems: Polished stainless steel.

2.4.6 Packing: Spring-loaded Teflon, self-adjusting.

2.4.7 Terminal Unit Control Devices: Provide compact electric control valves for control of terminal units including, but not necessarily limited to convectors, unit heaters, finned tube radiation, reheat coils, and fan coil units that are of integral motor type. Provide 2-position modulating type valves. Valve actuators shall be 24 volts 120 volts.

2.5 Dampers: Refer to Division-23 Section “Ductwork Accessories” for dampers. Actuators are work of this section.

2.6 Actuator Motors: Size each motor to operate dampers or valves with sufficient reserve power to provide smooth modulating action or two position action as specified.

2.6.1 Provide permanent split-capacitor or shaded pole type motors with gear trains completely oil-immersed and sealed. Equip spring-return motors, where indicated on drawings or in operational sequence, with integral spiral-spring mechanism. Furnish entire mechanism in housing designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

2.6.2 Equip motors for outdoor locations and for outside air intakes with "O-ring" gaskets designed to make motors completely weatherproof, and equip with internal heaters to permit normal operation at 10□F.

2.6.3 Furnish non-spring return motors for dampers larger than 25 sq. ft. and for valves larger than 2½". Size for running torque rating of 150 inch-pounds and breakaway torque rating of 300 inch-pounds. Size spring-return motors for running torque rating of 150 inch-pounds and breakaway torque rating of 150 inch-pounds.

2.7 EMCS/DDC Associated Components:

2.7.1 Provide field-programmable microprocessor-based, stand-alone EMCS/DDC panels as specified herein. The EMCS/DDC panel manufacturer shall be responsible for the complete engineering of the panel. The panel shall be UL listed and housed in a key locked metal cabinet . Parts shall be plug in (modular) for easy repair or expansion. Power input shall be 24V or 120 V. Relays and contacts shall be rated at 24 VA at 24 VAC or 125 VA at 120 and 230 VAC, as required.

2.7.2 The panels shall have the capability to be upgraded through modules.

2.7.3 Programming shall utilize low level English language.

2.7.4 Coordinate with the EMCS/DDC manufacturer and ensure that all wire and conduit (type and size) is suitable for the equipment being installed.

2.7.5 Each EMCS/DDC panel shall have at least the minimum number of output and input channels for controlling loads as shown on the drawings.

2.7.6 Panels shall have a keyboard with an access code to prevent unauthorized entry. The keyboard shall be used to display setpoints and valves, and for override and programming.

2.7.7 L.E.D. visual display shall provide prompted programming and shall indicate all system parameters including current time, day and month and error messages.

2.7.8 Provide for 48 hours minimum of battery backup for field programs in RAM. All logic, utility, calculations, and control functions shall be in ROM.

2.7.9 The control console shall have the capability to communicate with other system components by using a two-wire communication line.

2.7.10 The system shall be driven by a line power synchronized program clock. Clock display shall include year, month, day of month and time in hours, minutes and seconds. The clock shall also automatically update for days in month, daylight savings time, and leap year.

2.7.11 Programming shall be self-prompting such that the operator is guided to the next entry item. Field programming shall be readily accomplished by the user.

2.7.12 Diagnostics and Serviceability: Provide built-in, self-testing for lights, digital display, and memory. Provide all electronics in modular form of the plug-in type.

2.8 EMCS/DDC Functions:

2.8.1 Control Functions: Provide for closed-loop control by proportional, proportional-integral (PI), proportional-integral derivative (PID), incremental, and/or floating modes. Control accuracy: plus or minus 0.5° F of set point for all steady state load conditions. Provide specific control functions described in Division-23 section "HVAC Sequence of Operation".

2.8.2 Management Functions: Provide capability for trending of variables, totalizing, and historical data storage. Provide for monitoring of selected parameters locally and remotely.

2.8.3 Time of Day Program: Provide the ability to turn loads on and off per the input/output schedule and have a time initiate resolution of one minute. The system shall be designed such that equipment can have a different schedule each day of the week and multiple on-off schedules per day. The system shall include a holiday feature which shall include its own time schedules and holiday duration. It shall be possible to program holidays up to one year in advance. The program shall automatically changeover from Daylight Savings to Standard Time.

2.8.4 Duty Cycle Program: Provide ability to shed and restore loads and to automatically vary the off time of cycled equipment based on outdoor temperature. Use only for electric heaters. During the heating and cooling seasons the milder the temperature, the longer the off position of the cycle interval of the equipment being controlled. It shall be possible to modify the interval for each controlled load. The system shall use solid state temperature sensors which supply data to the system in order to determine off duration and the number of loads to be shed.

2.8.5 Demand Control: Provide kW demand limiting with adjustable load shedding (setpoint and schedule).

2.8.6 Optimized Start/Stop Program: The EMCS shall have the ability to vary the start time of heating system equipment based on outdoor air temperature. It shall be possible to modify the base start time, as well as the start time as a function of outdoor air temperature. The system shall utilize a solid state temperature sensor to determine startup time.

2.8.7 Chiller Optimization Program: The EMCS shall provide for optimization of chilled water supply temperature based on outdoor air temperature or chilled water return temperature as indicated. The system shall utilize solid state temperature sensors to determine optimized chilled water supply temperature.

2.8.8 Timed Override: Remote override timers (where indicated on the drawings and input/output schedule) shall enable after hour or off-schedule use of the controlled equipment.

2.8.9 Automatic Restart Programming: Provide for sequential automatic restart of all equipment in the normal mode following a power outage.

2.8.10 Temperature Indication: The EMCS shall monitor remote temperatures where indicated on the drawings and input/output schedule.

2.8.11 Energy Consumption: The EMCS shall have the ability to record 15 minute average analog readings for the past 48 hours and to monitor and record electric consumption for the past month.

2.8.12 Alarms: Provide alarms for control points out of range (adjustable) and provide alarm summary capability.

2.9 EMCS/DDC Associated Components:

2.9.1 Communication Module: The EMCS/DDC shall be supplied with all necessary communication modules and modems as required for a remote data terminal to program and recall data. The communication modules shall utilize voice grade telephone lines for this transmission and modems as required for a remote data terminal to program and recall data. The communication modules shall be connect to the telephone lines through a data access arrangement which protects the EMCS/DDC and telephone equipment from electrical surges. Provide all necessary equipment to allow remote programming and monitoring of input channels and on/off status from an IBM PC XT .

2.9.2 Remote Data Terminal: Where indicated, provide a complete microcomputer IBM PC XT or equal with disk drive, terminal, modem, monitor and printer. Provide software to program and recall data from all emote locations. The system shall be installed such that the operator can dial each EMCS panel via voice grade telephone circuits. It shall be possible to perform the following from the remote terminals.

2.9.2.1 Program the entire EMCS/DDC system.

2.9.2.2 Read system temperatures, determine system set points, determine load on-off status, and determine program function causing load status.

2.9.2.3 Perform energy audits, data gathering, and logging.

2.9.2.4 Troubleshoot the EMCS/DDC via diagnostic programs. The diagnostic messages displayed on the EMCS/DDC readout shall also be printed at the terminal when the system si interrogated.

2.9.3 Hardware: Provide key-locked NEMA-1 metal cabinet, modular components for expandability and maintenance, keyboard entry, battery backup to prevent loss of memory for at least 48 hours, local manual override, AC line voltage surge protection.

2.9.4 Channel Bypass and Override: Provide bypass switches for each output channel such that the controlled device can operate normally as if the EMCS/DDC was not installed. Provide remote override timers where shown in the input/output schedule on the drawings.

2.9.5 Associated Hardware: Provide actuators, relays, and other interface devices as required to execute the indicated control functions. Coordinate with Division-23 section "HVAC Control Sequences" and the input/output schedule on the drawings.

2.10 EMCS/DDC Input Devices:

2.10.1 Temperature Sensors: Provide nickel resistance temperature detector (RTD) type sensors for duct, well or room mounting as required by duty indicated. Accuracy: plus or minus 0.5□F.

2.10.2 Temperature Transmitters: Provide 3 or 4 wire resistance temperature detector (RTD) type transmitters for duct, well or room mounting as required by duty indicated. Provide metal enclosure sealed against moisture. Accuracy: plus or minus 0.25□F. Install wells to accommodate sensors. Wells must be of sufficient size to allow insertion of an electronic probe with the sensor for calibration. Accutech AI-1000 or approved equal.

2.10.3 Current Transformers: Provide current transformers (and potential transformers if required) and all associated interface equipment for sensing kW demand.

2.10.4 Hydronic Differential Pressure Transmitter: Provide self-contained, variable capacitance type differential pressure transmitters with the following features. Subject to compliance with requirements, provide transmitters of one of the following: Rosemont, Foxboro, Leslie, Yokagawa.

2.10.4.1 Sealed electronics compartment, suitable for duty at 90□F, 100% RH. Provide NEMA 4 enclosure.

2.10.4.2 Output 4-20 ma DC, isolated linear signal.

2.10.4.3 Design pressure: 2000 psi, design overrange differential: 2000 psi with minimal adverse affect on output.

2.10.4.4 Accuracy: plus or minus 0.25% of span.

2.10.4.5 Stability: plus or minus 0.25% of range limit.

2.10.4.6 Provide zero and span adjustments. Set span for each transmitter based on duty, not at maximum unless required.

2.10.4.7 Provide three-valve bypass manifold.

2.10.5 Magnetic Flow Meters: Flow meters shall be insertion type and shall operate on the electromagnetic induction principle. Unit shall provide an output signal directly proportional to the liquid rate of flow. Meters shall be selected for a maximum velocity of 15 feet per second at design flow rate. The magnetic flow meter shall include a flanged-style flow head with an integral or remote mounted signal converter as required for the project conditions. Johnson - Yokogawa or approved equal.

2.10.5.1 The magnetic flow meters shall be wet calibrated at the manufacturer's facility. A calibration certificate shall be provided for each meter and be traceable to the U.S. National Bureau of Standards. The accuracy of each meter, including the flow head and converter, shall be at least + or - 0.8% of measured value for velocities above 0.8 feet/second.

2.10.5.2 The flow head shall have a 304 stainless steel metering tube and liner suitable for the service to be encountered. End connections shall be steel flanged, ANSI Class 150. The flow head shall be epoxy coated steel and welded at all joints. The meter shall be suitably crated, including end covers to protect it during shipment and storage. The flow head shall have flat, elliptically-shaped, self-cleaning electrodes of 316 stainless steel. The field coils in the flow head shall be supplied with a precisely adjusted direct current which is periodically reversed from +125 mA to -125 mA. When installed in lined or non-metallic piping, the primary flow head shall be provided with 316 stainless steel grounding rings.

2.10.5.3 The converter shall be microprocessor based and fully field configurable for the measuring range, local indication and totalizing, pulse output, analog output, bi-directional flow, and low-flow cutoff. The converter shall have a NEMA 4, die-cast aluminum polyurethane-coated housing. The converter shall be capable of providing both analog and pulse outputs at the same time. The analog output shall be galvanically isolated, 4-20 or 0-20 mA, programmable, and capable of a 700-ohm load. The pulse output shall be galvanically isolated, 24 volt, and programmable from 50 to 360,000 pulses/hour. The converter shall have adjustable damping to provide response time from 0.2 to 1,000 seconds. The converter shall have a programmable 7-digit LCD display for flow rate in US GPM and for flow totalization. The converter shall be capable of monitoring the flow in both directions, providing pulse or analog signal output for both flow directions, totalizing in both directions, and summing the difference of the bi-directional flow. The converter shall be powered by a 115 VAC, 60 Hz, 6-watt source.

The magnetic flow meter shall be capable of operating in ambient temperatures from -15□ to 140□F. The unit shall operate at 200 psig safe working pressure at, 100□F.

2.10.6 Differential and Static Pressure Sensors (Air): Provide 0-6" w.g. adjustable in 2" w.g. span pressure sensors with □0.5% full scale accuracy. Provide zero and span adjustments. Provide over-pressure protection to 10 psig positive or negative.

2.10.7 Differential Pressure Switches (Air): Provide 0.05 to 5" w.g. differential pressure switches with adjustable setpoint and SPDT contact rated for duty indicated. Provide over-pressure protection to 1 psig positive or negative.

2.10.8 Humidity Sensors:

2.11 Guarantee:

2.11.1 All components, parts, and assemblies shall be guaranteed against defects in material and workmanship for a period of one year after acceptance. Expressed warranties are conditionally based on the requirement that the items covered within the guarantee are used and maintained in accordance with the manufacturer's recommendations. Guarantee commences at time of acceptance and continues for one year. Acceptance shall not occur until the Owner's operators are able to use the EMCS/DDC and receive reliable information from inputs and outputs.

2.11.2 The first year guarantee shall, as part of the base bid for the EMCS/DDC, include full service and maintenance of the EMCS/DDC. This service and maintenance shall include all necessary repair, reprogramming, calibration, cleaning, minimum (4) quarterly inspections, call back service, etc. This first year service, maintenance and guarantee shall be included in the base bid of the EMCS/DDC.

3 EXECUTION

3.1 Examine areas and conditions under which EMCS/DDC work is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.2 Installation of EMCS/DDC:

3.2.1 General: Install systems and materials in accordance with manufacturer's instructions, shop drawings, and details on drawings. Install electrical components and use electrical products complying with requirements of applicable Division-26 sections of these specifications. Mount panels at convenient locations and heights.

3.2.2 Control Wiring: The term "control wiring" is defined to include wire, conduit and miscellaneous materials as required for mounting and connecting electric control devices. Install all control wiring in conduit. All low voltage control wiring, except wiring located above accessible ceilings, shall be installed in conduit. Low voltage control wiring above accessible ceilings may be installed without conduit, provided it is run at right angles to the building structure and is tie-wrapped and supported per Division-26 and code requirements.

3.2.3 Wiring System: Install complete control wiring system for the EMCS/DDC. Conceal wiring, except in mechanical rooms and areas where other conduit and piping are exposed. Provide multi-conductor instrument harness (bundle) in place of single conductors where number of conductors can be run along common path. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.

3.2.4 Install control wiring in accordance with the National Electric Code and Division 26 requirements.

3.2.5 Number-code or color-code conductors, excluding those used for local individual room controls, appropriately for future identification and servicing of control system. Tag all sensor wiring to identify zone number and room number where sensor is located.

3.2.6 Label all sensors, valves, dampers, safety devices and controllers with engraved tags matching the shop drawings.

3.3 Programming of EMCS/DDC:

3.3.1 The Contractor shall obtain operational schedules for the controlled equipment from the Engineer. Submittal data relevant to operational schedules shall be forwarded from the Contractor to the Engineer. Upon receipt of approval, the Contractor shall proceed with installation, setup, calibration and check out of the various control and monitoring systems.

Having completed component and system installation, the Contractor shall submit a written request to the Engineer to inspect and approve their satisfactory operation.

3.3.2 The EMCS/DDC shall perform all functions on the equipment as describes in Division-23 section “HVAC Sequence of Operation and as called for in the input/output schedule on the drawings. This, in conjunction with the drawings, defines the scope and extent of the project with regard to the required number of panels, control point relays, and devices. Field verify voltages at point-of-interface and provide relays as required.

3.3.3 Channel numbers may be reassigned by the Contractor during shop drawing submittal.

3.3.4 Model numbers, horsepowers, voltages, and other information equipment where listed on the drawings are for Contractor's convenience. Verify all information in the field as necessary for preparation of shop drawings.

3.4 Functional Requirements of EMCS/DDC:

3.4.1 Provide all necessary relays, sensors, wiring and contacts to achieve proper operation.

3.4.2 Connect EMCS/DDC panels to remote panels where shown.

3.4.3 Coordinate EMCS/DDC work with pneumatic control work. Provide compatible equipment.

3.5 Adjusting and Cleaning:

3.5.1 Startup: Startup, test, and adjust the EMCS/DDC in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.5.2 Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.5.3 Final Adjustment: After completion of installation, adjust the program, relays, interface devices, and similar equipment provided as work of this section for optimum operation.

3.6 VFD System Adjustment: The drive/controller supplier shall set all adjustments and setpoints for initial operation. The hydronic system and all pumps and control valves shall be monitored for proper operation. The ductwork and all fans and terminal units shall be monitored for proper operation . It shall be recognized that final settings will be obtained by trial-and-error by necessity. Call backs to achieve proper settings shall be included in the base bid.

3.7 Owner's Instructions:

3.7.1 During system startup and at such time acceptable performance of the EMCS/DDC hardware and software has been established, the Contractor shall provide on-site operator instruction. This instruction shall be performed during normal working hours and shall be conducted by a competent representative of the Contractor familiar with the system's software, hardware and accessories. The Contractor shall maintain a roster of all attendees at all training sessions.

3.7.2 At a time mutually agreed upon during system training as stated above, the Contractor shall give up to 40 hours (as needed) of instruction to the Owner's designated personnel on the operation of all equipment within the EMCS/DDC and describe its intended use with respect to the programmed functions specified.

3.7.3 Operator orientation of the EMCS/DDC shall include, but not be limited to, the overall operational program, equipment functions both individually and as part of the total integrated system, commands, advisories, and appropriate operator intervention required in responding to the EMCS/DDC operation.

3.7.4 Provide at least 14-day notice to Owner and Engineer of training dates.

3.8 System Verification: The manufacturer's authorized representative shall state in writing to the Engineer that the EMCS/DDC system is operating properly, final adjustments and calibrations are complete, and Owner training has been accomplished.

**END OF SECTION 23 09 23**

# SECTION 23 31 13 - HVAC METAL DUCTWORK

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-23 Basic Mechanical Materials and Methods Sections apply to work of this section.

1.3 Extent of HVAC metal ductwork is indicated on drawings and in schedules, and by requirements of this section.

1.4 Refer to other Division-23 sections for exterior insulation of metal ductwork.

1.5 Refer to other Division-23 sections for ductwork accessories.

1.6 Codes and Standards:

1.6.1 SMACNA Standards: Comply with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible" 1985 Edition for fabrication and installation of metal ductwork, unless otherwise noted.

1.6.2 NFPA 90A Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.7 Approval Submittals:

1.7.1 Product Data: Submit manufacturer's technical product data and installation instructions for the following.

Factory-fabricated ductwork
Sealants
Duct liner
Adhesive
Flexible duct
Spin-in fittings
Side take-off fittings

1.7.2 Shop Drawings: Submit scaled layout drawings of HVAC metal ductwork and fittings including, but not limited to, duct sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between ductwork and proximate equipment. Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced.

2 PRODUCTS

2.1 Ductwork Materials:

2.1.1 Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting.

2.1.2 Galvanized Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lockforming quality; with G 90 zinc coating in accordance with ASTM A 525; and mill phosphatized for exposed locations. Stamp gauge and manufacturer's identification on each sheet. Break sheets so that identification is exposed.

2.2 Miscellaneous Ductwork Materials:

2.2.1 General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.

2.2.2 Duct Liner: Fibrous glass, 1½ pcf minimum density, complying with Thermal Insulation Manufacturers Association (TIMA) AHC-101; of thickness indicated. Certainteed "Coated Ultralite", Owens Corning "Aeroflex", PPG "Textrafine", or Manville "Linacoustic".

2.2.3 Duct Liner Adhesive: Comply with ASTM C 916 "Specifications for Adhesives for Duct Thermal Insulation".

2.2.4 Duct Liner Fasteners: Comply with SMACNA HVAC Duct Construction Standards, Article S2.11.

2.2.5 Duct Sealant: Provide non-hardening, non-migrating mastic or liquid elastic sealant, type applicable for fabrication/installation detail, as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork.

2.2.6 Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork. For exposed stainless steel ductwork, provide matching stainless steel support materials. For aluminum ductwork, provide matching supports unless materials are electrolytically separated from ductwork.

2.2.7 Flexible Ducts: Provide flexible ductwork with an R-value of R-6unless the ductwork is in a ceiling return plenum. The use of flexible ductwork for connection of supply air return air devices is acceptable only where shown on the drawings.

2.2.7.1 Construction: Provide reinforced metalized polyester jacket that is tear and puncture resistant, air tight inner core with no fiberglass erosion in the air stream and an encapsulated wire helix. Flexible ductwork shall have a recommended operating pressure of 6" w.g. for sizes 4" through 12" diameter and 4" w.g. for sizes 14" through 20" diameter.

All diameters shall be suitable for a negative operating pressure of 0.75" w.g. Flexible ductwork shall meet the requirements of UL-181, the Florida Energy Code, SBCC, NFPA 90A and NFPA 90B.

2.2.7.2 Acceptable Manufacturers: Subject to compliance with requirements, provide R-6 flexible ductwork by: Atco 36, Flexmaster 8M-R6 or Thermaflex M-KE R6.

2.2.8 Spin-in and Side Take-off Fittings: Provide round branch run-outs as follows.

2.2.8.1 Supply air diffuser connections shall be conical with damper and one inch high insulation stand-off equal to Crown 3200 DS or Flexmaster CBDE-BO.

2.2.8.2 Where duct height does not permit the use of conical spin-in fittings, use low profile side take-off fittings equal to Crown 3300-DS or Flexmaster STOD-BO.

2.2.9 Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15° change of direction per section. Unless specifically detailed otherwise, use 45° laterals and 45° elbows for branch takeoff connections. Where 90° branches are indicated, provide conical type tees.

2.3 Fabrication:

2.3.1 Shop fabricate ductwork in 4, 8, 10 or 12-ft lengths, unless otherwise indicated or required to complete runs. Preassemble work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark sections for reassembly and coordinated installation.

2.3.2 Shop fabricate ductwork of gauges and reinforcement complying with SMACNA "HVAC Duct Construction Standards", except provide sealant at all joints. supply duct from air conditioning units and all return and exhaust duct shall be minimum 2" pressure class unless otherwise noted.

2.3.3 Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to 1½ times associated duct width; and fabricate to include turning vanes in elbows where shorter radius is necessary. Limit angular tapers to 30° for contracting tapers and 20° for expanding tapers.

2.3.4 Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division-23 section "Ductwork Accessories" for accessory requirements.

2.3.5 Fabricate ductwork with duct liner in each section of duct where indicated. Laminate liner to internal surfaces of duct (100% coverage) in accordance with instructions by manufacturers of lining and adhesive, and fasten with mechanical fasteners (Grip Nails or Stic Klips) on 16 centers. On horizontal runs install top and bottom first and wedge sides between top and bottom. Apply a brush coat of fire retardant over all joints, visible cut edges, and leading edges to prevent erosion.

2.4 Factory-Fabricated Low Pressure Ductwork (Maximum 2" W.G.):

2.4.1 Material: Galvanized sheet steel complying with ASTM A 527, lockforming quality, with ASTM A 525, G90 zinc coating, mill phosphatized.

2.4.2 Gauge: 28-gauge minimum for round ducts and fittings, 4" through 8" diameter. 26-gauge minimum 9" through 14", 24-gauge minimum 15" through 26".

2.4.3 Elbows: One piece construction for 90° and 45° elbows 14" and smaller. Provide multiple gore construction for larger diameters with standing seam circumferential joint.

2.4.4 Divided Flow Fittings: 90° tees, constructed with saddle tap spot welded and bonded to duct fitting body.

2.4.5 Acceptable Manufacturers: Subject to compliance with requirements, provide factory-fabricated ductwork by Semco Mfg., Inc. or United Sheet Metal Div., United McGill Corp, or approved equal.

2.5 Factory-Fabricated High Pressure Ductwork (3" W.G. and Higher):

2.5.1 Round Ductwork: Construct of galvanized sheet steel complying with ASTM A 527 by the following methods and in minimum gauges listed.

| Diameter | Minimum Gauge | Method of Manufacture |
|---|---|---|
| 3" to 14" | 26 | Spiral Lockseam |
| 15" to 26" | 24 | Spiral Lockseam |
| 27" to 36" | 22 | Spiral Lockseam |
| 37" to 50" | 20 | Spiral Lockseam |
| 51" to 60" | 18 | Spiral Lockseam |
| Over 60" | 16 | Longitudinal Seam |

Provide locked seams for spiral duct; fusion-welded butt seam for longitudinal seam duct.

Fittings and Couplings: Construct of minimum gauges listed. Provide continuous welds along seams.

| Diameter | Minimum Gauge |
|---|---|
| 3" to 36" | 20 |
| 38" to 50" | 18 |
| Over 50" | 16 |

2.5.2 Flat-Oval Ductwork: Construct of galvanized sheet steel complying with ASTM A 527, of spiral lockseam construction, in minimum gauges listed.

| Maximum Width | Minimum Gauge |
|---|---|

| | |
|---|---|
| Under 25" | 24 |
| 25" to 48" | 22 |
| 49" to 70" | 20 |
| Over 70" | 18 |

Fittings and Couplings: Construct of minimum gauges listed. Provide continuous weld along seams.

| Maximum Width | Minimum Gauge |
|---|---|
| Under 37" | 20 |
| 37" to 50" | 18 |
| Over 50" | 16 |

2.5.3 Internally Insulated Duct and Fittings: Construct with outer pressure shell, 1" thick insulation layer, and perforated inner liner. Construct shell and liner of galvanized sheet steel complying with ASTM A 527, of spiral lockseam construction, use longitudinal seam for over 59", in minimum gauges listed.

| Nominal Duct Diameter | Outer Shell | Inner Liner |
|---|---|---|
| 3" to 12" | 26 ga. | 24 ga. |
| 13" to 24" | 24 ga. | 24 ga. |
| 25" to 34" | 22 ga. | 24 ga. |
| 35" to 48" | 20 ga. | 24 ga. |
| 49" to 58" | 18 ga. | 24 ga. |
| Over 59" | 16 ga. | 20 ga. |

Fittings and Couplings: Construct of minimum gauges listed. Provide continuous weld along seams of outer shell.

| Nominal Duct Diameter | Outer Shell | Inner Liner |
|---|---|---|
| 3" to 34" | 20 ga. | 20 ga. |
| 36" to 48" | 18 ga. | 20 ga. |
| Over 48" | 16 ga. | 20 ga. |

Inner Liner for Straight Duct: Perforate with 3/32" holes for 22% open area. Provide metal spacers welded in position to maintain spacing and concentricity. Provide a plastic film between the perforated liner and insulation to act as a vapor barrier.

Inner Liner for Fittings: Solid sheet metal. Provide metal spacers welded in position to maintain spacing and concentricity.

Mylar Film: Provide interior mylar film on interior liner.

2.5.4 Optional Ducts and Fittings: At Installer's option, provided that certified tests by Manufacturer show that rigidity and performance is equivalent to SMACNA standard gauge

ductwork, provide ducts and fittings as follows:

Ducts: Construct of Manufacturer's standard gauge, with spiral lock seam and intermediate standing rib.

Fittings: Construct by fabricating with spot welding and bonding with neoprene-base cement in lieu of continuous weld seams.

2.5.5 Acceptable Manufacturers: Subject to compliance with requirements, provide factory-fabricated ductwork Semco Mfg., Inc. or United Sheet Metal Div., United McGill Corp., or approved equal.

3 EXECUTION

3.1 General: Examine areas and conditions under which HVAC metal ductwork is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 Installation Of Metal Ductwork:

3.2.1 General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air-tight (5% leakage for systems rated 3" and under; 1% for systems rated over 3") and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor.

3.2.2 Supports: Install concrete inserts for support of ductwork in coordination with formwork, as required to avoid delays in work. Install self-drilling screw anchors in prestressed concrete or existing work.

3.2.3 Field Fabrication: Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements. Seal joints in round or oval ductwork with hard cast or shrink bands, and sheet metal screws, or by welding.

3.2.4 Routing: Locate ductwork runs, except as otherwise indicated, vertically and horizontally. Avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to ½" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. In finished and occupied spaces, conceal ductwork from view by locating in mechanical shafts, hollow wall construction or above suspended ceilings, unless specifically noted as "Exposed". Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

3.2.5 Internally Lined Ductwork: Cover leading and trailing edge of duct liner with sheet metal nosing zee.

3.2.6 Electrical Equipment Spaces: Do not route ductwork through transformer vaults or other electrical equipment spaces and enclosures.

3.2.7 Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 1½". Fasten to duct and substrate. Where ducts pass through fire-rated floors, walls, or partitions, provide firestopping between duct and substrate.

3.2.8 Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.

3.2.9 Installation: Install metal ductwork in accordance with SMACNA HVAC Duct Construction Standards. Fan discharge outlet ducts shall be installed correctly with regard to "system effect" per AMCA Publication 201.

3.3 Installation of Flexible Ducts:

3.3.1 Maximum Length: For any duct run using flexible ductwork, do not exceed 5'-0" extended length. Flexible duct shall only be allowed as detailed on the drawings.

3.3.2 Installation: Install in accordance with Section III of SMACNA's "HVAC Duct Construction Standards, Metal and Flexible". Support flexible ducts to eliminate pinching and kinking which would restrict flow.

3.3.3 Peel back insulation and slide the inner core over the spin-in or diffuser neck, seal with duct sealant and install Panduit strap tightly. Slide insulation back over the inner core and install another Panduit strap over the insulation outer jacket. Tape is not acceptable.

3.3.4 Seal all exposed edges of fiberglass insulation with glassfab and mastic.

3.4 Leakage Tests: After each duct system is completed, test for duct leakage in accordance with Sections 3 and 5 of the SMACNA HVAC Air Duct Leakage Test Manual. Test pressure shall be equal to pressure class of duct, less 0.5" static pressure. Repair leaks and repeat tests until total leakage is less than 5% of system design air flow for low pressure systems and less than 1% for systems rated over 3".

3.5 Equipment Connections: Connect metal ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors as indicated.

3.6 Clean ductwork internally free of dust and debris. Clean external surfaces of foreign

substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration. Keep ducts closed with poly during construction to prevent contamination by construction dust and debris.

3.7 Balancing: Refer to Division-23 section "Testing, Adjusting, and Balancing" for air distribution balancing of metal ductwork; not work of this section. Seal any leaks in ductwork that become apparent in balancing process.

3.8 System Adjustment: Adjust the system to provide functional operation to the extent possible, and leave ready for Testing and Balancing work. It is not the intent of this section to provide final testing and balancing, but to leave the system operational with a minimum of noise.

**END OF SECTION 23 31 13**

# SECTION 23 33 00 - DUCTWORK ACCESSORIES

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.3 Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this section.

1.4 Refer to other Division-23 sections for testing, adjusting, and balancing of ductwork accessories; not work of this section.

1.5 Codes and Standards:

1.5.1 SMACNA Compliance: Comply with applicable portions of both SMACNA "HVAC Duct Construction Standards, Metal and Flexible" and "Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems".

1.5.2 UL Compliance: Construct, test, and label fire dampers in accordance with UL Standard 555 "Fire Dampers and Ceiling Dampers". Construct, test and label smoke dampers in accordance with UL Standard 555S "Leakage Rated Dampers for use in Smoke Control Systems" .

1.5.3 NFPA Compliance: Comply with applicable provisions of NFPA 90A "Air Conditioning and Ventilating Systems" pertaining to installation of ductwork accessories.

1.6 Approval Submittals:

1.6.1 Product Data: Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction; and installation instructions as follows:

Low pressure manual dampers
Control dampers
Fire dampers
Smoke dampers
Duct access doors
Flexible connections

1.6.2 O&M Data Submittals: Submit manufacturer's maintenance data including parts lists for fire dampers, smoke dampers. Include this data, product data, and a copy of approval submittals in O&M manual.

2 PRODUCTS

2.1 Dampers:

2.1.1 Low Pressure Manual Dampers: Provide 16 gauge dampers of single-blade type (12"

maximum blade width) or multiblade type. Damper blades to be gang-operated from a single shaft with nylon or ball bearings on each end. Provide indexed locking quadrant. Parallel or opposed blade style is acceptable. Provide 2" standoff on locking quadrant for externally insulated duct.

2.1.2 Control Dampers: Extruded aluminum (6063-T5) damper frame shall not be less than 0.080" in thickness. Damper frame shall be 4" deep x 1", with duct mounting flanges on both sides of frame. Damper frame shall have a 2" mounting flange on the rear of the damper when installed as Extended Rear Flange install type. Aluminum frame shall be clear anodized to a minimum thickness of 0.7 mil deep. Frame shall be assembled using stainless steel screws. Welded frames shall not be acceptable. Actuators (motors) are provided by mechanical contractor.

2.1.2.1 Blades shall be maximum 6.4" deep extruded aluminum (6063-T5) air-foil profiles with a minimum wall thickness of 0.06", clear anodized to a minimum thickness of 0.7 mil deep.

2.1.2.2 Blade seals shall be extruded silicone, secured in an integral slot within the aluminum blade extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals will not be approved.

2.1.2.3 Hexagonal control shaft shall be $^{7}/_{16}$". It shall have an adjustable length and shall be an integral part of the blade axle. A field-applied control shaft shall not be acceptable. All parts shall be stainless steel.

2.1.2.4 Linkage hardware shall be aluminum and stainless steel, installed in the frame side, out of the airstream, and accessible after installation. Linkage hardware shall be complete with stainless steel cup-point trunnion screws to prevent linkage slippage. Linkage that consists of metal rubbing metal will not be approved.

2.1.2.5 Dampers shall be designed for operation in temperatures ranging from -40°F to 212°F.

2.1.2.6 Dampers shall be AMCA rated for Leakage Class 1A at 1 in w.g. static pressure differential. Standard air leakage data to be certified under the AMCA Certified Ratings Program.

2.1.2.7 Dampers shall be custom made to required size, with blade stops not exceeding 1¼" in height.

2.1.2.8 Dampers shall be opposed blade for modulating dampers or parallel blade action for open/shut dampers.

2.1.2.9 Dampers shall be installed in the following manner: Installed in Duct

2.1.2.10 Installation of dampers must be in accordance with manufacturer's current installation guidelines, provided with each damper shipment.

2.1.2.11 Field supplied intermediate structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width.

2.1.2.12 Acceptable Manufacturers: Subject to compliance with requirements, provide control dampers by TAMCO (T.A. Morrison & Co, Inc), Ruskin TED50CD, Greenheck VCD33, or approved equal.

2.1.3 Acceptable Manufacturers: Subject to compliance with requirements, provide dampers by Air Balance, American Warming & Ventilating, Arrow Louver and Damper, Penn Ventilator Co., or Ruskin Mfg. Co.

2.2 Fire and Smoke Dampers:

2.2.1 Fire Dampers: Provide curtain type fire dampers, UL classified and labeled per UL 555, of types and sizes indicated. Construct casings and blades of galvanized steel. Damper shall not restrict duct free area when open. Dampers shall be rated for dynamic closure under flow and pressure. Provide sleeves and mounting angles. Provide fusible link rated at 160 to 165° F unless otherwise indicated. Provide damper with positive lock in closed position. All dampers shall be spring activated. Basis of design:

1-1/2 HR: Ruskin IBD2 - Style B for rectangular, Style CR for round, Style CO for oval.

1-1/2 HR: Ruskin IBDT for transfer grilles in narrow partitions.

3 HR: Ruskin IBD23 - Style B for rectangular, Style CR for round, Style CO for oval.

2.2.2 Smoke Dampers: Provide motorized smoke dampers, UL classified under UL-555S, of types and sizes indicated. Construct frame and blades of galvanized steel. Provide sleeves. Provide damper assembly complete with electric operator that will fail safe if fire interrupts operational power. Provide for remote testing or resetting capability after response to smoke detector operation. Entire assembly shall be rated at least leakage class II (10 CFM/sq. ft. at 1" w.g. at 250□F). Basis of design:

Systems to 1,500 FPM duct velocity or 2.5" w.g.: Class II Ruskin SD36.

Systems over 1,500 FPM duct velocity or 2.5" w.g.: Class I, airfoil blades, Ruskin SD60.

2.2.3 Fire/Smoke Dampers: Provide motorized combination fire/smoke dampers, UL classified under UL-555 and UL-555S in types and sizes indicated, with casing constructed of galvanized steel, and galvanized steel interlocking blades. Provide factory furnished sleeves and angles. Provide damper assembly complete with electric operator that will fail safe if fire interrupts operational power. For low leakage applications, entire assembly shall be rated at least leakage class I (4 CFM / sq. ft. at 1" w.g. at 250□F. Entire assembly shall be rated at least leakage class II (10 CFM/sq. ft. at 1" w.g. at 250□F). Provide for remote testing or resetting capability after response to smoke detector operation. Provide fusible link rated at 160 - 165□F unless otherwise indicated that will close the damper under fire conditions and not permit operation by actuator until link is replaced. // Provide firestat rated at 160 - 165□F unless otherwise noted to electrically close the damper under fire conditions with remote testing or resetting capability after response to firestat operation, and with position indicator switches. Basis of design:

Systems to 1,500 FPM duct velocity or 2.5" w.g.: Class II, Ruskin FSD36.

Systems over 1,500 FPM duct velocity or 2.5" w.g.: Class I, airfoil blades, Ruskin FSD60.

2.2.4 Acceptable Manufacturers: Subject to compliance with requirements, provide fire and smoke dampers by Air Balance, Inc., American Warning & Ventilating, Arrow Louver and Damper, Penn Ventilator Co., or Ruskin Mfg. Co.

2.3 Turning Vanes: Provide manufactured or fabricated single wall turning vanes and vane runners, constructed in accordance with SMACNA "HVAC Duct Construction Standards".

2.4 Duct Access Doors:

2.4.1 General: Provide duct access doors of size indicated, or as required for duty indicated.

2.4.2 Construction: Construct of same or greater gauge as ductwork served. Provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors.

2.4.3 Acceptable Manufacturers: Subject to compliance with requirements, provide access doors by Air Balance, Inc., Duro Dyne Corp., Ruskin Mfg. Co., or Ventfabrics, Inc.

2.5 Flexible Connections:

2.5.1 General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.

2.5.2 Acceptable Manufacturers: Subject to compliance with requirments, provide products by one of the following: Duro Dyne Corp., Flexaust (The) Co., or Ventfabrics, Inc.

3 EXECUTION

3.1 Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 Installation of Ductwork Accessories:

3.2.1 Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

3.2.2 Install balancing dampers at all main ducts adjacent to units in return air, outside air and where indicated.

3.2.3 Install control dampers in the outside air duct for each air handler. Damper operator provided by control contractor.

3.2.4 Install turning vanes in square or rectangular 90□ elbows in supply, return, and exhaust air systems, and elsewhere as indicated.

3.2.5 Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter. Install on entering air side of reheat coils. Install at smoke detectors. Install at fire dampers and smoke dampers.

Opening size shall be minimum 12”x12” for servicing fire and smoke dampers. Provide label with 1-1/2" letters to indicate location of fire protection devices.

3.2.6 Install flexible connections in ductwork such that the clear length of the connector is approximately two inches. Provide thrust restraints as required. Flexible material shall not be so slack as to take a definite concave or convex shape during fan operation.

3.2.7 Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.2.8 Install fire dampers within fire walls and floors at locations shown on the mechanical drawings. Install in strict accordance with the manufacturer's printed instructions, NFPA 90A, and UL 555. Basis of design installation is detailed on the drawings.

3.2.9 Install smoke dampers on both sides of air handling units (to include filters) in units over 15,000 cfm. Install at smoke partitions. All locations are shown on the mechanical drawings. Install in strict accordance with the manufacturer's printed instructions, NFPA 90A, and UL 555S. Basis of design installation is detailed on the drawings.

3.3 Fire and Smoke Dampers: Notify Engineer at least 24 hours in advance of ceiling installation or chase closure so that complete fire and smoke damper installation can be observed. A copy of the manufacturer’s printed installation instructions shall be available at the site.

3.4 Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories as required to obtain proper operation and leakproof performance.

3.5 Adjusting And Cleaning:

3.5.1 Adjusting: Adjust ductwork accessories for proper settings. Install fusible links in fire dampers and adjust for proper action.

3.5.2 Final positioning of manual dampers is specified in Division-23 section "Testing, Adjusting, and Balancing". However, the system shall be left functional with all dampers open or throttled.

3.5.3 Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.5.4 Furnish extra fusible links to Owner, one link for every 10 installed of each temperature range; obtain receipt.

**END OF SECTION 23 33 00**

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# SECTION 23 34 00 - FANS

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.3 Extent of fan work required by this section as indicated on drawings and schedules, and by requirements of this section.

1.4 Coordination:

1.4.1 Refer to Division-7 sections for installation of prefabricated roof curbs; not work of this section. Furnishing prefabricated roof curbs is part of this section's work.

1.4.2 Refer to Division-23 section "Testing, Adjusting, and Balancing" for balancing of fans.

1.4.3 Refer to Division-23 HVAC control systems sections for control work required in conjunction with fans.

1.4.4 Refer to Division-26 sections for power supply wiring from power source to power connection on fans. Division-26 work will include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

1.5 Codes and Standards:

1.5.1 AMCA Compliance: Provide fans which have been tested and rated in accordance with AMCA standards, and bear AMCA Certified Ratings Seal.

1.5.2 UL Compliance: Provide fans which are listed by UL and have UL label affixed.

1.6 Approval Submittals:

1.6.1 Product Data: Submit manufacturer's technical data for fans, including specifications, capacity ratings, dimensions, weights, materials, accessories furnished, and installation instructions. Submit assembly-type drawings showing unit dimensions, construction details, methods of assembly of components, and field connection details. Include statement that resin selection is suitable for chemical resistance to the specific application at 170ºF.

1.6.1.1 Fans

1.6.1.2 Vibration Control

1.7 O&M Data Submittals: Submit maintenance data and parts list for each type of fan, accessory, and control. Include these data, a copy of approved submittals, and wiring diagrams in O&M Manual.

2 PRODUCTS

2.1 General: Except as otherwise indicated, provide standard prefabricated fans of type and size indicated, modified as necessary to comply with requirements, and as required for complete installation. Provide accessories as listed in the schedule on the drawings and as described herein. Motors shall be high efficiency per Division-23 section "Motors".

2.2 Acceptable Manufacturers: Subject to compliance with requirements provide fans manufactured by Acme, Greenheck, Loren Cook, Penn or approved equal unless otherwise noted herein.

2.3 Centrifugal Ceiling Exhausters:

2.3.1 Fan Assembly: Provide steel housing, plastic or aluminum grille, backdraft damper, statically and dynamically balanced fan wheel, permanently lubricated motor with internal thermal overloads, vibration isolation and all required mounting hardware and brackets. Provide acoustically treated housing for all fans larger than 60 cfm. Mounting type shall be as indicated on the drawings or on the schedule.

2.3.2 Connectors: Provide adaptors, connectors, and eave elbows as required to connect fan discharges to outlets.

2.3.3 Outlets: Provide where shown on the drawings (or required by the installation) wall caps, vent caps, or roof jacks, each with birdscreen, to match fans and surrounding construction.

2.4 In-Line Centrifugal Fans:

2.4.1 Housing: Provide round aluminum or square weather tight housing constructed of steel and painted inside and out with an epoxy finish. Provide venturi type inlet.

2.4.2 Fan Wheels: Provide aluminum air foil type, backward curved, statically and dynamically balanced.

2.4.3 Drive: Provide direct or belt drive as scheduled with pre-lubricated, ball bearing, continuous duty type motors. Provide vibration isolation equipment for the entire drive.

2.4.4 Isolation and Support: Provide spring type vibration isolators and fan support brackets.

2.5 Fan Accessories and Features: Where indicated on the schedule or drawings provide accessories and features listed herein.

1 Direct drive: Direct drives shall have multispeed motors or speed controllers to achieve scheduled flow.

2 Bird Screens: Provide bird screens of 1/2" mesh aluminum or galvanized steel hardware cloth.

3 Backdraft Dampers: Provide where indicated aluminum louvered dampers with felt-edged blades and nylon bearings.

4 Disconnect Switches: Provide factory installed local disconnecting means.

5 Thermal Overloads: Provide internal thermal overloads.

6 Speed Controller: Provide where indicated solid state speed controller for remote mounting.

2.6 Vibration Isolation: Mount fans on vibration isolators in accordance with the requirements of Division-23 section "Vibration Isolation" and the following list.

2.6.1 Hangers: Type HA1, HA2, HA3.

3 EXECUTION

3.1 General: Except as otherwise indicated or specified, install fans in accordance with manufacturer's installation instructions and recognized industry practices to insure that fans serve their intended function.

3.2 Coordinate fan work with work of walls and ceilings as necessary for proper interfacing. Framing of openings, caulking, and curb installation is not work of this section.

3.3 Ductwork: Refer to Division-23 section "Ductwork". Connect ducts to fans in accordance with manufacturer's installation instructions. Provide flexible connections in ductwork at fans.

3.4 Install fans on vibration isolation equipment as required. Set level and plumb.

3.5 Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical Installer. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Verify proper rotation direction of fan wheels. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.6 Remove shipping bolts and temporary supports within fans. Adjust dampers for free operation.

3.7 Testing: After installation of fans has been completed, test each fan to demonstrate proper operation of units at performance requirements specified. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

3.8 Cleaning: Clean factory-finished surfaces. Remove all tar and soil. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

**END OF SECTION 23 34 00**

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# SECTION 23 37 13 - GRILLES, REGISTERS AND CEILING DIFFUSERS

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.3 Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this section.

1.4 Refer to other Division-23 sections for ductwork and duct accessories required in conjunction with air outlets and inlets and for balancing of air outlets and inlets; not work of this section.

1.5 Codes and Standards:

1.5.1 ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual". Provide air outlets and inlets bearing ADC Certified Rating Seal.

1.5.2 NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.6 Approval Submittals:

1.6.1 Product Data: Submit manufacturer's technical product data for air outlets and inlets indicating construction, finish, and mounting details.

1.6.2 Performance Data: For each type of air outlet and inlet furnished, provide aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections and data as required.

1.7 O&M Data Submittals: Submit cleaning instructions for finishes and spare parts lists. Include this data and a copy of approval submittals in O&M manual.

2 PRODUCTS

2.1 General:

2.1.1 Except as otherwise indicated, provide manufacturer's standard grilles, registers, and ceiling diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

2.1.2 Manufacturers not listed in the following specification will not be considered for approval unless accepted by addendum prior to bid.

2.1.3 Performance: Provide grilles, registers and ceiling diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device equal to the basis of design.

2.1.4 Ceiling and Wall Compatibility: Provide grilles, registers and diffusers with border styles that are compatible with adjacent wall and ceiling systems, and that are specifically manufactured to fit into ceiling module or wall with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems and walls which will contain each type of ceiling diffuser, grille, or register.

2.1.5 Appearance: All grilles and registers shall be aluminum construction and all diffusers shall be aluminum construction, unless otherwise noted, with uniform matching appearance for each type of outlet. Ceiling mounted grilles and registers shall be set to be sight tight from the predominant exposure.

2.1.6 Finish: All ceiling mounted grilles, registers, and diffusers shall be finished with baked white enamel. Wall and door mounted grilles and registers shall be finished with clear anodized finish baked white enamel.

2.2 Acceptable Manufacturers: Subject to compliance with requirements, provide products by Titus, Price, Greenheck, or Metal Aire.

2.3 Square Ceiling Diffusers: Provide square face, adjustable, 360 degree pattern diffusers with one-piece stamped cones, no corner joints, round necks. Provide lay-in panel as required.

2.4 Round Ceiling Diffusers: Provide round face, adjustable diffusers with one-piece cones; no seams.

2.5 Ceiling Linear Diffusers: Provide linear supply and return slot diffusers with full 180 degree adjustable air pattern and complete flow control including blank off. Number and size of slots are shown on the drawings. Provide joining and alignment strips, end caps, mitred corners, and frame type suitable for ceiling installation. Provide 1 inch slot unless otherwise noted on the drawings. Provide insulated plenums for supply diffusers.

2.6 Return and ExhaustGrilles: Provide return grilles with one set of 45 degree fixed louvers, parallel to the long dimension. Provide mounting frame for all wall and plaster ceiling installations.

## 3 EXECUTION

3.1 Coordinate installation with ceiling and light fixture installation. Locate ceiling outlets as indicated on architectural Reflected Ceiling Plans. Unless otherwise indicated, locate ceiling outlets in the center of acoustical ceiling modules with sides parallel to the grid.

3.2 Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions.

3.3 Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.

3.4 Set air volumes to values shown on the drawings so that the system is functional. Leave ready for test and balance contractor.

3.5 Furnish to Owner three operating keys for each type of outlet and inlet that require them; obtain receipt.

**END OF SECTION 23 37 13**

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# SECTION 23 37 26 - WALL LOUVERS

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.3 Extent of wall louver work is indicated by drawings and schedules, and by the requirements of this section.

1.4 Refer to other Division-23 sections for ductwork, duct accessories and controls work.

1.5 AMCA Compliance: Test and rate louvers in accordance with AMCA Standard 500. Provide AMCA certified rating seal. Ratings based on tests and procedures performed in accordance with AMCA 500-L and complying with the AMCA 511 Certified Ratings Program. AMCA Certified Ratings Seal applies to air performance, water penetration and wind driven rain ratings.

1.6 Product Qualifications:

1.6.1 Florida Product Approved Louvers:

1. Miami-Dade County, Florida Notice of Acceptance (NOA).
2. Florida Building Code Approval.
3. Louver shall be certified to Florida Building Code Testing Application Standards TAS 100(A) (Wind Driven Rain Resistance), TAS 201 (Large Missile Impact), TAS 202 (Uniform Static Air Pressure) and TAS 203 (Cyclic Wind Loading).
4. AMCA Listed for compliance to AMCA 540 Level E and AMCA 550 standards.

1.7 Approval Submittals:

1.7.1 Product data: Submit manufacturer's technical product data for louvers including: model number, accessories furnished, construction, finish, mounting details, performance data.

1.8 O&M Data Submittals: Submit maintenance data, including cleaning of finishes and a copy of approval submittals. Include in O&M manual.

2 PRODUCTS

2.1 Acceptable Manufacturers: Subject to compliance with requirements, submit products by Ruskin, Greenheck, Arrow, American Warming and Ventilating, or AMCA labeled approved equal.

2.2 General: Except as otherwise indicated, provide manufacturer's standard louvers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation. Provide Kynar 500 coated, corrosion resistant finish and 5 year warranty; color to be selected by the Owner.

2.3 Substrate Compatibility: Provide Florida Product approved louvers with 9 inch frame with flange and sill extension piece that are compatible with adjacent substrate, and that are

specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate which will contain each type of louver.

2.4 Materials:

2.4.1 Florida Product Approved Louvers: Construct of aluminum extrusions, Alloy 6063-T6 0.081" thick for frame and 0.081" thick for front blades and 0.060" thick for back blades. Weld units or use stainless steel fasteners.

2.5 Sill Flashing: Formed aluminum, 0.080" thick, upturned sides to prevent water leakage.

2.6 Installation Angles: Material: 1.375 x 2.25 inch x 0.125 inch thick continuous aluminum angles around louver perimeter for installation in concrete, deep CMU, steel and wood substrate wall systems.

2.7 Installation Plates: Material: 0.250 inch (6.4 mm) thick continuous aluminum flat or zee plates for installation in thin CMU substrate wall systems.

2.8 Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.

2.9 Stationary Florida Product Approved Louvers: Hurricane and impact rated louvers, basis of design is Greenheck EHV-901D.

2.10 Performance Data

2.10.1 EHV-901D:

1. Performance Ratings: AMCA licensed.
   a. Based on testing 48 inches x 48 inches size unit in accordance with AMCA 500-L.
2. Free Area: 42 percent, nominal.
3. Free Area Size: 6.66 square feet.
4. Maximum Recommended Air Flow through Free Area: 2,155 feet per minute.
5. Air Flow: 10,431 cubic feet per minute.
6. Maximum Pressure Drop (Intake): 0.60 inches w.g..
7. Water Penetration: Beginning point of water penetration of 0.01 ounce per ft² of free area shall be above 1,250 feet per minute free area velocity.
8. Wind Load Rating: Maximum wind load of ±150 PSF.
9. AMCA 500-L Wind Driven Rain Performance: 99.9 percent effective at preventing water penetration through louver when tested at 50 miles per hour wind with 8 inches per hour rainfall and 2,155 feet per minute airflow through the free area. Penetration Class 'A' with Discharge Class (Intake) '3' in accordance with AMCA 500-L Wind Driven Rain Test.

3 EXECUTION

3.1 Install where shown on the drawings in accordance with the manufacturer's printed instruction and Florida Product Approval. Exercise care to prevent scratches.

3.2 Isolate dissimilar metals per the manufacturer's recommendations.

3.3 Verify size of louvers shown on drawings prior to fabrication. Coordinate with wall openings. Sizes may be altered subject to approval by Engineer provided free area remains approximately the same as indicated.

END OF SECTION 233726

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## SECTION 23 81 03 - OUTSIDE AIR PRECONDITIONING UNITS

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.3 Refer to other Division-23 sections for testing, adjusting, and balancing of air conditioning units (OAUs).

1.4 Approval Submittals:

1.4.1 Product Data: Submit manufacturer's technical product data, including dimensions, ratings, electrical characteristics, weight, capacities, materials of construction, and installation instructions.

Preconditioning units
Vibration isolation
Refrigerant Line Shop Drawings

1.5 Test Reports and Verification Submittals:

1.5.1 Submit Startup Report by factory-trained representative.

1.6 O&M Data Submittals: Submit manufacturer's maintenance data including parts lists. Include these data, a copy of approval submittals, product data, and wiring diagrams in O&M manual.

2 PRODUCTS

2.1 Quality Assurance:

2.1.1 Construct refrigeration system in accordance with ASHRAE 15 (ANSI B 9.1) "Safety Code for Mechanical Refrigeration".

2.1.2 Provide units with an EER that meets the Florida Energy Efficiency Code and the schedules on the drawings.

2.1.3 Electrical installation will comply with the requirements of Division 26, National Electrical Code.

2.1.4 Provide the units produced by a recognized manufacturer who maintains a local service agency and parts stock.

2.1.5 Equivalent selections must have airflow rates, external static pressures, coil face velocities, filter face velocities and air side pressure drop that equal or exceed specified performance.

2.1.6 Startup supervision will be provided by the Manufacturer.

2.1.7 Equipment within the units will be ETL/UL listed where applicable.

2.1.8 Acceptable Manufacturers: Subject to compliance with requirements provide units by Dectron, Multistack, or approved equal.

2.2 General:

2.2.1 Units shall be factory-assembled, wired and tested. All controls shall be factory-adjusted and preset to the design conditions.

2.2.2 Provide factory fabricated modular DOAS units and remote condenser units having overall dimensions as shown on the construction plans. Physical dimensions and unit arrangement are designed and manufactured specifically to meet the requirements shown on the equipment plans and specifications.

2.2.3 The units will be designed to maintain optimum comfort levels.

2.2.4 Refer to the unit schedule to determine the performance of internal components.

2.2.5 The indicated total static pressure for each air stream must be equal to the sum of external static pressures and internal static including system effects and safety.

2.2.6 All deviations from the specified must be clearly indicated on the submittal drawings.

2.2.7 The contractor is responsible for all additional expenses associated with the substitution of the specified product.

2.2.8 Units will be fully inspected by the engineer and if required, owner or representative.

2.3 Casings:

2.3.1 All panels will be 1” thick composite panels, constructed of cast and extruded aluminum faming components.

2.3.2 Structural-strength acrylic adhesive and silicone caulk beads create a dual sealing mechanism.

2.3.3 Non-Thermal Break. Panels consist of a closed cell insulating foam sandwiched between corrugated plastic stabilizers and pre-finished aluminum sheets.

2.3.4 Inner panels will be 1” 28GA aluminum.

2.3.5 Outer panels will be 1” 28 GA Aluminum.

2.3.6 R-value for 1” panel: 5

2.4 Access doors:

2.4.1 Access doors will be the same construction as the panels.

2.4.2 The removable door panels will be aluminum.

2.4.3 Each access door will have panel blocks.

2.5 Drain Connection: The drain pan will be 304 Stainless Steel, 1-1/2" OD PVC Drain connection with internal P-Trap.

2.6 Piping connections: All piping connections that extend to the exterior of the casing will do so through neoprene rubber seals. Cooling Coils will be sealed from the interior and exterior of the unit.

2.7 Fan section Fan will be directly mounted on the panel. Electric heaters will be shipped loose and mounted on the supply air opening.

2.8 Fans:

2.8.1 Single-sided intake, rear-curved motor impeller, energy-optimized for operation without spiral housing through special blade design with rotating, vaneless diffuser for high efficiency and with favorable acoustic behavior.

2.8.2 Impeller: ø 350 mm.

2.8.3 Centrifugal impeller is made of aluminum (AlMg3) or steel metal coated with quartz grey (RAL7039). External rotor motor statically and dynamically balanced according to DIN ISO 21940-11.

2.8.4 Impeller with rotating diffuser.

2.8.5 7 rear-curved, curved blades and galvanized inlet nozzle.

2.8.6 Design with integrated electronics Over-temperature protection of the device electronics through active temperature management.

2.8.7 Motor is made of die casted aluminum.

2.8.8 Insulation class F and Protection Class IP54, the permissible ambient temperature is -4°F (-20°C) to +140°F (60°C).

2.8.9 Low noise commutation, integrated motor protection, 100% speed controllable.

2.8.10 IP54 Rating for Fan Protection.

2.9 Refrigeration System:

2.9.1 Direct expansion evaporative coil

1. The coils will be designed for use with R-454B refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes with 16GA Stainless Steel end casings. Fin design will be sine wave rippled.

2. The coils will be helium leak tested and be furnished with factory-installed thermostatic expansion valves. The tubes will have a nominal diameter of ⅜" and 0.012" thick rifled wall. Heat transfer fins will have a nominal thickness of 0.010''.

3. Each coil will have air pressure tested up to 900 psig under water, completely dehydrated and pressure tested with refrigerant.

4. The coils will be coated with 16,000 hours (Salt Spray Corrosion ASTM B117) AA corrosion protection coating.

2.9.2 Electronic expansion valve

1. Electronic Expansion Valve (EEV) will be designed for installation in refrigerant circuits as the refrigerant expansion device. The superheat will be used as the trigger for the control signal. The EEV will be double-acting. The EEV will be joined to the circuit by braze welding the copper fittings to the condenser outlet (IN) and the evaporator inlet (OUT) pipes. The EEV will be able to operate up to 653 psi (45 bars). The EEV will have 750 control steps. The step speed will be 50ms (150 steps/second).

2. Electronic Expansion Valve (EEV) will be always in compartment out of air stream accessible.

2.9.3 Hot gas reheat coil

1. Coils will be designed for use with R-454B refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes with 16GA Stainless Steel end casings. Fin design will be sine wave rippled.

2. Coils will be helium leak tested and furnished with factory. The tubes will have a nominal diameter of ⅜" and 0.012" thick rifled wall. Heat transfer fins will have a nominal thickness of 0.010''.

3. Each coil will have air pressure tested up to **900** psig under water, completely dehydrated.

4. Coils will be coated with 16,000 hours (Salt Spray Corrosion ASTM B117) AA corrosion protection coating.

2.9.4 Compressors

1. Digital compressors will be hermetic scroll type with thermal overload protection.

2. The compressor will be capable of modulation from 25–100% of its capacity and will provide continuous and precise modulation.

3. Compressors will be individually circuited and mounted in an isolated vestibule, out of the air stream, with service access.

4. All refrigeration circuits will be equipped with low pressure and high-pressure safety controls, service type fittings on high and low-pressure sides and factory installed liquid line filter driers.

5. The scroll compressor will be equipped with an external solenoid valve specified by compressor manufacturer, suction and discharge piping will be sized for 100% refrigerant mass flow.

6. The scroll compressor will have a minimum 20-minute cycle on time and a minimum 20-minute cycle off time to prolong scroll compressor life.

7. A crankcase heater will be installed for each digital compressor. Polyol ester oil (POE OIL) will be used as the oil type of choice.

2.9.5 REMOTE AIR-COOLED CONDENSER

1. Each DOAS Unit will be equipped with air conditioning feature to reject all compressor heat to an outdoor air-cooled condenser.

2. The outdoor condenser will be equipped with a transformer and 24VAC control including contactor for fan motor.

3. The unit will be provided with a dry contact rated for 24VAC/5A to operate the remote outdoor condenser control.

4. Refrigeration circuit will include three-way refrigerant valve, receiver with pressure relief valve set at 650 psig sized to hold the outdoor condenser charge, pressure control valve and pressure differential valve, and two shutoff valves to isolate the outdoor condenser.

2.9.6 R454B Refrigerant: Refrigerant R454B is fully field supplied & charged by others.

2.10 Air Filters

2.10.1 Provide all filters of number, size and capacity as required for air handling system indicated on drawings. Filters are to be selected for a maximum face velocity of 500 fpm.

2.10.2 Filters: 2" thick MERV 13 efficiency (per ASHRAE Test Standard 52.2-2007) pleated filters.

2.10.3 Filters will have a nominal rating of 500 fpm. Each cell will be 16" x 20”.

2.10.4 The initial pressure drop will not exceed that indicated. Media will be approved and listed as Underwriters Laboratories Class 2 when tested according to UL Standard.

2.10.5 Filters will be side loading.

2.11 Outdoor Air Damper (Insulated)

2.11.1 OA Damper frame will have prefabricated aluminum extrusions. Damper blades shall be airfoil type, double wall, opposed and be made of aluminum extrusions. Air seal gaskets shall be made of synthetic rubber type TPE and EPDM. Dampers shall be thermally insulated. Complete blades shall have an insulation factor of R-2.29 and a temperature index of 55.

2.11.2 All drive shafts shall be located out of the air stream, and it shall be possible to install the actuators inside the cabinet without interference to the airflow.

2.11.3 The damper is AMCA rated for Leakage Class 1A at 1 in w.g. (0.25 kPa) differential static pressure.

2.11.4 The actuator for the damper is sized and installed by the factory. It has a feedback terminal so that the damper can regulate the airflow.

2.12 Electronics:

2.12.1 Control panels

1. The unit will be complete with an ETL listed and NEMA rated electrical control panel, which Include contactors, motor protectors, relays, and transformers.

2. All branch circuits will be individually protected and will include a low-voltage control circuit transformer.

3. Motors and compressors will be protected at all phases.

4. Units will be provided with phase and brown out protection that shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, 10% under design voltage or on phase reversal.

5. The control panel will be used to house, but not limited to:

   Microprocessor controller
   Valve and Temperature Control Boards
   Blower Contactors
   Fuses
   Fuse Holders
   Terminal Strips
   Phase monitors
   Universal Power Supply
   Transformers
   Super Heat Controllers

6. The control panel will be unit mounted, recessed to the unit and accessible from the exterior of the unit.

7. The control panel will be enclosed in an isolated compartment outside of the air stream.

2.13 Microprocessor: Microprocessor will feature a multitasking operating system compatible with the pCO5 Sistema family of devices, which includes programmable controllers, user terminals, gateways, communication devices and remote management devices. These devices will be interface-friendly with most Building Management Systems (BMS) available on the market. The controller will have been developed by CAREL. Microprocessors will be able to connect via Ethernet LAN to other pCO5 family controllers. Each device in the LAN will be able to exchange digital or analog variables with all the others, based on the application program used. Microprocessors will be able to connect via a pLAN (pCO Local Area Network) to the pGD range of terminals. Each Fieldbus serial port, whether built into the controller or installed via an optional card, will be able to connect to controlled field devices such as valve and damper actuators and external drivers (e.g. drivers for electronic

expansion valves, EVD Evolution). Each BMS serial port, whether built into the controller or installed via an optional card, will be able to connect to field-level, automation-level or management-level standard bus system BACnet. The real-time operating system (OS) will manage priorities to ensure the application program cycle time, 32bit data and floating-point numbers, and the Ethernet multimaster and multi-protocol connection. If equipped with a front panel, it will include a 6-backlit-button keypad which when pressed individually or in a combination will allow the operations of uploading an application program or commissioning. During regular operation and depending on the application program installed, the terminal will be able to edit the main operating parameters and to display the quantities measured, the active functions and any detected alarm.

The microprocessor will be equipped with the following features:

- Optimization of the memory occupied by the Operating System and the application program, of the boot time, of the time for loading the application program and of the cycle time.
- System response time optimization: the controller executes several processes in parallel, each managed with a different priority.
- Independent processes: each process, whether a protocol, USB port management, data and alarm log (data logger), works independently of the others.
- Runtime debug (on target).
- Native management of MS/TP multitasking protocol.
- Built-in web server, completely customizable, supports HTML standard and JavaScript. The 90 Mbyte memory can be used to store pages created using the most common website development tools. Dynamic methods (CGI, Common Gateway Interface) are available to read and write the application program variables. Other innovative functions include: the possibility to display the contents of the pGD1 terminal in the browser, display graphs of data recorded by the data logger and plot data from probes and energy meters in real time (variable trends).
- File server (FTP): the pCO5 public file system can be accessed in the local network via FTP. Consequently, an FTP client can be used to connect to the controller so as to upload updates, web pages and documents. The ".csv" (comma separated value) fi les exported by the data logger can be downloaded.
- Creation of accounts with different access privileges, associated to both a webserver and an FTP server.
- Connection of BACnet MSTP protocol with B-BC profile. Integrated USB peripheral which will be able to be used to update the controller and save web pages, documents and applications in flash memory, and to download the logs from the controller.
- Will be able to connect to up to 3 pGD1\pGDE terminals
- Will have universal inputs/outputs configurable via an application program for connecting active and passive probes, digital inputs, analog and PWM outputs.
- Will have label with QR code containing the MAC address that uniquely identifies the controller on the Ethernet network.

## 2.14 INPUTS AND OUTPUTS

The Microprocessor will be compatible for with the following:

- Analog inputs of type: NTC PTC, PT500, PT1000, 0-1VDC, 0-10VDC, 0-20mA, 4-20mA and 0-5V. Digital inputs of type: voltage-free contact and fast digital input.
- Analog outputs of type: 0-10VDC and PWM.

The control program will be factory developed to user specification, factory tested and loaded into the controller. Through the operator panel, the user will be able to set/perform the following functions:

1. Compressor auto/off mode
2. Blower auto/off mode
3. Manual reset
4. Service mode for demand forcing (password protected)

Change humidity and temperature setpoints, deadbands and differentials (password protected)

5.Sensor calibration (password protected)

Unit Mounted Sensors:

1. Air Proving Switch
2. Supply Fan Outlet High Static Limit Switch
3. Air Filter Dirty Switch
4. Entering Air temperature/RH sensor
5. DX Leaving Air Temperature Sensor
6. Shipped loose Supply Air Temperature Sensor

2.15 REMOTE OUTDOOR AIR-COOLED CONDENSER

2.15.1 UNIT CASING: Direct Coil Air cooled condensers are fabricated with 16-gauge Galvanized Steel with structural members made of 14 or 12 gauges as required for maximum support. The mounting design is easy to ship, fast for rigging and installation.

2.15.2 FAN MOTOR ASSEMBLY: All fans operate in fully baffled sections to provide efficient heat transfer and prevent wind milling. The condenser unit is provided with 2 fans, each consisting of an 800 mm diameter 3.1KW ZIEHL-ABEGG High Efficiency EC Fan motor or equal. Fans are provided with sickle blades for quiet operation and the normal speed motor enables the fan to produce sound pressure levels of 61 dBA at 10m. Fans are speed controlled in response to load demands by a pressure sensing transducer. Motors have Thermal Overload Protector, moisture, and hot climate protection. Motors are rated for 208/3/60 Main Power.

2.15.3 CONDENSER COIL: High heat transfer Copper - 0.014 Plain Tube & Aluminum 0.010 Corrugated Fin coils of generous face area with tubes mechanically expanded into self-spacing fin collars for maximum heat transfer. All coils have a maximum operating pressure of 600 psig. Coils are factory leak tested at 600 psig with dry air and sealed prior to shipment. Copper headers are used for inlet and outlet with Sweat – Copper connections for field connections.

2.16 Paint and Finish: Prior to painting, all metal part shall be pretreated to remove oils and dirt and rinsed with an ionized solution. Painting shall be by a powder coat technique to assure positive adherence with a high-impact finish. All sides of panels shall be painted after manufacturing. The paint shall be high yield polyester. The paint shall be rated to a minimum of 1000 hour salt spray test (ASTM B117), have a minimum Direct Impact Resistance of 160 in-lbs (ASTM D2794), have a minimum flexibility of ¼" Mandrel (ASTM D522, Method B) and a minimum 1000 hour Humidity Resistance (ASTM D2247).

2.17 Basic Vibration Isolation: Provide vibration isolation products complying with Division-23 section "Vibration Isolation" and the following list:

2.17.1 Equipment Mounting: Type EM1

2.18 Warranty: Manufacturer shall provide one year parts and labor warranty.

2.19 Shop Drawings: Provide scaled factory approved refrigerant line layout showing the actual routing on site, including all elevation changes and elbows. Drawings should indicate total length and size of refrigerant piping between indoor and outdoor units and elevations for indoor and outdoor equipment.

3 EXECUTION

3.1 Installation: Install in accordance with producer's printed instructions. Brush out fins on all coils.

3.2 Mount units on vibration isolation and concrete housekeeping pads.

3.3 Refrigerant Piping: Comply with ANSI B31.5, “Refrigerant Piping,” (except lower pressure limits below 15 psig), and ASHRAE 15 (ANSI B9.1). Make all joints carefully and neatly. Clean pipe and fittings before fluxing. Remove burrs. Braze by the sweat method using Sil Fos. Install field installed refrigerant devices and valves as required.

3.3.1 Refrigerant Piping Layout: Any deviations from the factory approved shop drawings shall be approved by the factory prior to system startup.

3.4 Testing: After job erection, or modification of factory installed piping, pressure test for leaks at 150 psig using a nominal amount of a suitable tracer refrigerant and dry nitrogen or a suitable refrigerant. Perform leak tests with an electronic halide leak detector having a sensitivity of at least ½ ounce R-12 per year. Refrigeration piping will not be accepted unless it is gas tight.

3.5 Evacuation: After completing the successful pressure test, multiple-evacuate the system. Leave the compressor isolation valves shut and connect the vacuum pump to both the high and low sides. Evacuate the system to an absolute pressure of 1,500 microns. Then break vacuum to 2 psig with dry nitrogen. Repeat this process. Install the proper biflow drier in the liquid line and evacuate the system to 500 microns. Leave vacuum pump running for at least two hours without interruption. Break vacuum with the refrigerant to be used and raise pressure to 2 psig. Do not operate compressors during the evacuation procedure.

3.6 Charging: After completing the successful evacuation procedure, charge refrigerant directly to the system from the original containers through a filter drier. Charge to the manufacturer’s stated conditions of pressure for required temperature. Weigh the refrigerant added and record on the startup report.

3.7 Controls: Set up controls for units as described in Sequence of Operations.

3.8 Cleaning: Clean tar and all other soil from housing exterior. Leave ready for Division 7, Caulking Work. Caulk around pipe sleeves.

3.9 Construction Filters: Provide 4" thick filters in all units during construction. After

construction (but prior to the test and balance being performed) install clean final filters.

3.10 Condensate Drain: Pipe trapped copper condensate drain (full size of unit outlet) to nearest floor drain or as shown on the drawings. Refer to Division-23 section "Insulation" for pipe insulation.

3.11 Startup: Startup by a factory-trained representative. Check entire assembly for correctness of installation, alignment, and control sequencing. Start all component parts in proper sequence. Make all adjustments required to insure proper control and smooth quiet operation. Submit Startup Report.

**END OF SECTION 23 81 03**

# SECTION 23 81 28 - DUCTLESS SPLIT SYSTEM AIR CONDITIONING UNITS

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.3 Refer to other Division-23 sections for testing, adjusting, and balancing of units; not work of this section.

1.4 Approval Submittals:

1.4.1 Product Data: Submit manufacturer's technical product data, including dimensions, ratings, electrical characteristics, weight, capacities, materials of construction, and installation instructions. Submit assembly-type drawings showing all piping and electrical connections and all mounting requirements. Show methods of fastening and assembly of components. Provide wiring diagrams.

1.5 O&M Data Submittals: Submit manufacturer's maintenance data including parts lists. Include these data, product data, and a copy of approval submittals in O&M manual.

2 PRODUCTS

2.1 Quality Assurance:

2.1.1 Test and rate split system air conditioning units in accordance with ARI Standard 210, 240 or 360 as applicable, and provide certified rating seal.

2.1.2 Construct refrigeration system of split system air conditioning units in accordance with ASHRAE 15 (ANSI B 9.1) "Safety Code for Mechanical Refrigeration".

2.1.3 Provide split system air conditioning units with an SEER that meets the Florida Energy Efficiency Code and the schedule on the drawings.

2.1.4 Provide split system air conditioning units that are designed, manufactured, and tested in accordance with UL or ETL requirements.

2.1.5 Acceptable Manufacturers: Submit to compliance with requirements, provide units by Sanyo, Toshiba, Mitsubishi, or approved equal.

2.2 General:

2.2.1 Casings: Construct of painted mill galvanized steel (or aluminum) formed panels rigidly reinforced and braced. Each unit shall be provided with removable panels to permit the unit (including fans and compressors) to be properly maintained and serviced.

2.3 Condensing Unit:

2.3.1 Condenser Fans and Drives: Fan shall be of rustproof construction, hot dipped galvanized steel, stainless steel or aluminum. Unit shall have weather protected totally enclosed motor. Provide a close fretwork galvanized steel or non-ferrous fan guard. Motors shall be

the permanently lubricated type, resiliently mounted.

2.3.2 Condenser Coil: Construct of non-ferrous tubes and aluminum fins. Provide inlet guard to protect condenser fins.

2.3.3 Compressor: Shall be scroll or hermetic design with vibration isolation. Compressor shall not produce objectionable noise or vibration inside the building. Compressors shall have five (5) year warranty.

2.3.4 Service Valves: Provide for high and low pressure readings.

2.4 Evaporator Unit:

2.4.1 Interior of unit shall be thermally and acoustically insulated with 1 inch fiberglass duct liner insulation. Provide removable panels to permit the unit to be properly serviced and maintained.

2.4.2 The evaporator section shall include centrifugal fan, two-speed fan motor, and direct drive. Provide cooling coil, snap out washable filters, refrigerant drier, controls and other necessary devices for a completely automatic unit. Coils shall have copper tubes and aluminum fins. Provide automatic oscillating louver action to facilitate air distribution.

2.5 Controls:

2.5.1 All safety and operational controls shall be factory wired.

2.5.2 Provide remote microprocessor-based controls with room thermostat, timer and fan speed switch.

2.6 Refrigerant Piping:

2.6.1 Copper tubing 3/4" and smaller: Type ACR, soft annealed temper; cast copper-alloy fittings for flared copper tubes; flared joints.

2.6.2 Brazing material: Silver solder bearing at least 15% silver; Sil Fos.

3 EXECUTION

3.1 Installation: Install in accordance with producer's printed instructions.

3.2 Refrigerant Piping: Comply with ANSI B31.5, "Refrigerant Piping," (extend lower pressure limits below 15 psig), and ASHRAE 15 (ANSI B9.1). Make all joints carefully and neatly. Clean pipe and fittings before fluxing. Remove burrs. Braze by the sweat method using Sil Fos.

3.3 Testing: After job erection, pressure test for leaks at 150 psig using a nominal amount of a suitable tracer refrigerant and dry nitrogen or a suitable refrigerant. Perform leak tests with an electronic halide leak detector having a sensitivity of at least 1/2 ounce R-12 per year. Refrigeration piping will not be accepted unless it is gas tight.

3.4 Evacuation: After completing the successful pressure test, multiple-evacuate the system. Leave the compressor isolation valves shut and connect the vacuum pump to both the high

and low sides. Evacuate the system to an absolute pressure of 1,500 microns. Then break vacuum to 2 psig with dry nitrogen. Repeat this process. Install the proper biflow drier in the liquid line and evacuate the system to 500 microns. Leave vacuum pump running for at least two hours without interruption. Break vacuum with the refrigerant to be used and raise pressure to 2 psig. Do not operate compressors during the evacuation procedure.

3.5 Charging: After completing the successful evacuation procedure, charge refrigerant directly to the system from the original containers through a filter drier. Charge to the manufacturer's stated conditions of pressure for required temperature. Weigh the refrigerant added and record on the startup report.

3.6 Cleaning: Clean tar and all other soil from housing exterior. Leave ready for Division 7, Caulking Work. Caulk around pipe sleeves.

3.7 Condensate Drain: Pipe trapped copper condensate drain to outside the building or to a point of disposal as shown on the drawings. Pipe shall be full size of unit outlet. Refer to Division-23 section "Insulation" for pipe insulation.

3.8 Startup: Check entire assembly for correctness of installation, alignment, and control sequencing. Start all component parts in proper sequence. Make all adjustments required to insure proper smooth quiet operation.

END OF SECTION

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# SECTION 23 81 30 VARIABLE REFRIGERANT VOLUME HEAT PUMP SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes complete VRF HVAC system(s) which may include, but not limited to, the following components:

1. Indoor, multi position air handling units
2. Outdoor, air-source heat recovery units.
3. VRF system controls.
4. VRF system refrigerant and oil.
5. VRF system condensate drain piping.
6. VRF system refrigerant piping.
7. VRF system control cable.

### 1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Nationally recognized manufacturer of VRF HVAC systems and products.
2. Shipped VRF HVAC systems with similar requirements to local market for a continuous period of 10 years within time of bid.
3. VRF HVAC systems and products that have been successfully tested and in use on at least five completed projects.
4. Having complete published online catalog literature, installation, and operation and maintenance manuals for all products intended for use. Resources must be publicly available without login or sign-in as registered account.
5. Having full-time in-house employees for the following:
   a. Product research and development.
   b. Product and application engineering.
   c. Product manufacturing, testing, and quality control.
   d. Technical support for system installation training, startup, commissioning, and troubleshooting of installations.
   e. Owner training.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.

1. Each employee shall be certified to have successfully completed manufacturer training for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
2. Installer certificate shall be valid and current for duration of Project.
3. Retain copies of Installer certificates on-site and make available on request.
4. Each person assigned to Project shall have demonstrated past experience.
   a. Demonstrated past experience with VRF products being installed for period within five consecutive years before time of bid.
   b. Demonstrated past experience on five projects of similar VRF system complexity, scope, and value.

C. ISO Compliance: System equipment and components furnished by VRF HVAC system

manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.

B. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

C. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

1.4 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures.
   b. Faulty operation.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
2. Warranty Period:
   a. For Compressor,10 year(s) from date of Substantial Completion.
   b. For Parts,10 year(s) from date of Substantial Completion.

B. Installer’s Labor Warranty: Installer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.

1. Warranty Period 2year(s) from date of substantial completion.

PART 2 - PRODUCTS

2.1 VRF HVAC SYSTEMS

A. Manufacturers: Basis of design is CITY MULTI. Subject to compliance with requirements, provide products by one of the following brands only:

1. Mitsubishi Electric & Electronics USA, Inc.
2. Trane, Inc.
3. Toshiba Carrier Co., Ltd.
4. Daikin Applied
5. Johnson Controls, Inc.

2.2 SYSTEM DESCRIPTION

A. VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, outdoor units with heat recovery, piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.

1. System(s) operation being heat pump or heat recovery as indicated on Drawings.
2. Each system with one refrigerant circuit serving all indoor units connected to system.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA

70, by a qualified testing agency, and marked for intended location and application.

C. AHRI Compliance: System and equipment performance certified according to AHRI 1230-2023.

D. UL Compliance: Comply with UL 60335-2-40.

2.3 VERTICAL/HORIZONTAL DUCTED (MULTI-POSITION AIR HANDLER)

A. Description: The multi-position indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall be suitable for use in air handling spaces in accordance with Section 18.2 of UL 1995 4th Edition, be tested in accordance with ANSI/ASHRAE 193 and have less than 2% air leakage at maximum airflow setting.

B. Cabinet:

1. Material: Painted steel.
2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
3. Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
4. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
5. The cabinet shall include a fixed bottom return, a fixed vertical discharge supply, and be prepainted, preinsulated 22 gauge galvanized steel.
6. Unit shall have R-4.2 insulation.

C. Coil Assembly:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
2. Testing: Factory pressure tested and verified to be without leaks.

D. Fan and Motor Assembly:

1. The indoor unit fan shall be an assembly with a single, statically and dynamically balanced direct drive fan with a high efficiency DC motor with permanently lubricated bearings.
2. The fan shall have 3-speeds with the capability to operate between 0.3-0.8 In.WG selectable.

E. Filter Assembly:

1. The unit shall have a 1” filter rack with a reusable filter.

F. Unit Controls:

1. Control board shall include contacts for control of no less than two stages of external heat. The first stage of external heat may be energized when the space temperature is 2.7°F from set point for between 10-25 minutes (user adjustable). The second stage of external heat may be energized when the first stage has been active for no less than 5 minutes and the space temperature has not risen by more than 0.9°F.

2. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
3. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

G. Unit Electrical:

1. Field Connection: Single point connection to power unit and integral controls.
2. Disconnecting Means: Field-installed circuit breaker or switch.

## 2.4 OUTDOOR, AIR-SOURCE HEAT RECOVERY UNITS

A. Description: Factory-assembled and tested complete unit designed for use in systems with simultaneous heating and cooling.

1. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit, heat recovery control unit(s), and multiple indoor units.

B. Cabinet:

1. Galvanized steel and coated with a corrosion-resistant finish.
   a. Coating with documented salt spray test performance of 1000 hours according to ASTM B117 surface scratch test (SST) procedure.
2. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Compressor and Motor Assembly:

1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive. Non-inverter compressors—where LRA applies—are not allowed.
2. Protection: Integral protection against the following-
   a. Refrigerant overcharge and undercharge
   b. High and low refrigerant pressure.
   c. High refrigerant and oil temperature.
   d. Liquid flood back.
   e. Thermal and overload.
   f. Voltage fluctuations.
   g. Phase failure and phase reversal.
   h. Short cycling.
3. Speed Control: Configurable to maintain refrigerant evaporating and condensing temperatures while varying refrigerant flow to satisfy cooling and heating loads.
   a. Cooling mode fixed 32°F evaporator temperature.
   b. Cooling mode fixed 43°F evaporator temperature.
   c. Cooling mode variable 32-48°F evaporator temperature.
   d. Heating mode high COP operation.
   e. Heating mode high heating output operation.
4. Vibration Control: Integral isolation to dampen vibration transmission.
5. Oil Management: Timed sequence enabled during extended periods of reduced refrigerant flow to ensure proper lubrication over entire operating range. Sequences which rely on sensing oil level risk sensor failure or sensor placement not accounting for line length and are not allowed.
6. Crankcase heaters with integral control to maintain safe operating temperature.
7. Fusible plug.

D. Heat-Exchanger Assembly: Documented salt spray test performance of 1000 hours according to ASTM B117 surface test (SST) procedure.

1. Plate Fin Coils:
   a. Casing: Aluminum, galvanized, or stainless steel.
   b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
   c. Tubes: Copper, of diameter and thickness required by performance.
2. Zinc-Coated Aluminum Microchannel Coils:
   a. Series of flat tubes containing a series of multiple, parallel flow microchannels layered between refrigerant header manifolds.
   b. Construct fins, tubes, and header manifolds of aluminum alloy.
   c. Provide coil panel heaters for heating operation below 0°F per Drawings.

E. Heat-Exchanger Defrost Strategy:

1. Alternate methods based on ambient temperatures.
   a. Hot-gas method to maximize efficiency during mild ambient temperatures. Method prolongs defrost sequence.
      1) Segmented coil (single-module systems) or alternating modules (twinned systems) to deliver simultaneous defrost and HEAT delivery indoors.
   b. Reverse-cycle method to maximize comfort during extreme ambient temperatures. Method shortens defrost sequence.
      1) Leverage below 33.8°F for single-module systems and below 23°F for twinned systems to deliver shorter defrost cycles.
2. Preheat Defrost Operation: Signal to indoor units operating in HEAT to increase space temperature before the start of defrost sequence.

F. Heat-Exchanger Fan and Motor Assembly:

1. Fan(s): Propeller type.
   a. Direct-drive arrangement.
   b. Fabricated from non-ferrous components.
   c. Statically and dynamically balanced.
2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for heat exchanger coil.
3. Motor(s): Brushless DC or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.

G. Field-Installed Unit Accessories:

1. Low Ambient Cooling Kit: Provide heat-exchanger coil wind deflectors and fan hood assembly for low ambient cooling operation to -10°F.

2. Refrigerant Filter/Cleaning System: Replaceable filter core in bypass arrangement from main suction flow to enhance installation quality assurance.

H. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:
   a. Refrigerant suction temperature.
   b. Refrigerant discharge temperature.

c. Outdoor air temperature.
d. Refrigerant high pressure.
e. Refrigerant low pressure.

4. Features and Functions: Self-diagnostics, time delay, auto-restart.
5. Interlock control sequence: Customizable operation based on external input or contact closure. Required interlock sequence(s) include-
   a. Compressor on/off and fault status.

I. Unit Electrical:

1. Field Connection: Single point connection to power each unit module and integral controls.
2. Disconnecting Means: Field-installed circuit breaker or switch, complying with NFPA 70.

## 2.5 VRF SYSTEM CONTROLS

A. General Requirements:

1. Network: Indoor units and outdoor units shall include integral controls and connect through a manufacturer-selected control network.
2. Network Communication Protocol: Manufacturer proprietary control communication between interconnected units.
3. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL), including the following-
   a. Ethernet connection via RJ-45 connectors and port with transmission at [**100**]<**Insert value**> Mbps or higher.
   b. Integration shall include [**control**][**monitoring**][**scheduling**][**change of value notifications**]<**Insert requirements**>.
   c. <**Insert requirements**>.
4. Operator Interface:
   a. Operators shall interface with system and unit controls through the following:
      1) Operator interfaces integral to controllers
      2) Integration with Building Automation System.
   b. Users shall be capable of interface with controllers for indoor units' control to extent privileges are enabled. Control features available to users shall include the following:
      1) On/off control.
      2) Temperature set-point adjustment.
      3) Fan speed control.
   c. Interface via secure-cloud access shall allow downloading of system diagnostic information, viewable system diagnostic charts, and email notification of error codes.

B. VRF HVAC System Operator Interface via PC:

1. Central controller(s) connected local-area-network shall be accessible through standard web browser software requiring no manufacturer-specific software be installed on owner-furnished PC.
2. Browser interface shall provide operator with a graphic user interface to allow monitoring and control of multiple central controllers from a single device location through point-and-click mouse exchange.
3. Plan views shall show building plans with location of indoor units and identification superimposed on plans.
4. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through

central controller shall match those operation modes of controllers for indoor units.

5. Schedules operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Schedules daily, weekly, and annual events.
6. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
7. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
8. Supports Multiple Languages: English, French, or Spanish.
9. Supports Imperial and Metric Temperature Units
10. Displays service notifications and error codes.
11. Monitors and displays cumulative operating time of indoor units.
12. Able to disable and enable operation of individual controllers for indoor units.
13. Information displayed on individual controllers shall also be available for display.

C. Central Controllers:

1. Centralized control for all indoor and outdoor units from a single central controller location.
   a. Include multiple interconnected controllers as required.
   b. Include backlit, high-resolution color display touch panel.
2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
   a. Sets schedule for daily, weekly, and annual events.
   b. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.
4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
5. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
7. Able to disable and enable operation of individual controllers for indoor units.
8. Information displayed on individual controllers shall also be available for display through central controller.
9. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.
10. Start/stop control capability for third-party equipment as required.
11. Niagara Driver for direct BMS connection to central controller(s) for enhanced data set including indoor unit and control points plus outdoor unit monitor points in lieu of BACnet license.

D. Wired Controllers and Sensors for Indoor Units

1. Deluxe Controllers for Indoor Units:
   a. Single controller capable of controlling multiple indoor units as group.
   b. Integral room temperature sensor
   c. Configurable LCD Touch Screen with Auto Timeout: Timeout duration shall be adjustable.
   d. Temperature Units: Fahrenheit and Celsius.
   e. On/Off: Turns indoor unit on or off.

f. Hold: Hold operation settings until hold is released.
g. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
h. Temperature Display and Set-Point: Separate set points for Cooling, Heating. Adjustable in 1-degree Fahrenheit increments between.
i. Fan Speed Setting: Select between available options furnished with unit.
j. Airflow Direction Setting: If applicable to indoor unit style, select between available options furnished with the unit.
k. Seven-day programmable operating schedule with up to five events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
l. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
m. Service Notification Display: "Filter".
n. Service Run Tests: Limit use by service personnel to troubleshoot operation.
o. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
p. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
q. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost.
r. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.

## 2.6 VRF SYSTEM REFRIGERANT AND OIL

A. Refrigerant:

1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.
2. ASHRAE 34, Class A1 refrigerant classification.
3. R-410a.

B. Oil:

1. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

## 2.7 VRF SYSTEM CONDENSATE DRAIN PIPING

A. If more than one material is listed, material selection is Contractor's option.

B. Copper Tubing:

1. Drawn-Temper Tubing: According to **ASTM B88, Type L**.
2. Wrought-Copper Fittings: ASME B16.22.
3. Wrought-Copper Unions: ASME B16.22.
4. Solder Filler Metals: ASTM B32, lead-free alloys, and water-flushable flux according to ASTM B813.

C. Reducers: Where applied to piping connected to unit-mounted integral lifting mechanism, only eccentric reducers oriented horizontally are allowed.

## 2.8 VRF SYSTEM REFRIGERANT PIPING

A. Refrigerant Piping:

1. Copper Tube: ASTM B280, Type ACR.
2. Wrought-Copper Fittings: ASME B16.22.
3. Brazing Filler Metals: AWS A5.8/A5.8M.

B. Refrigerant Tubing Kits:

1. Factory-rolled and -bundled, soft-copper tubing with tubing termination fittings at each end.
2. Standard one-piece length for connecting to indoor units.
3. Pre-insulated with flexible elastomeric insulation of thickness to comply with governing energy code and sufficient to eliminate condensation.
4. Factory Charge: dehydrated air or nitrogen.

C. Assemblies and Specialties:

1. Divided-Flow Specialty Fittings: Where required by VRF HVAC system manufacturer for proper system operation, VRF HVAC system manufacturer shall furnish specialty fittings with identification and instructions for proper installation by Installer.
2. Refrigerant Isolation Ball Valves: Uni-body full port design with Schrader valve for refrigerant service, rated for maximum system temperature and not less than 800 psig pressure, and factory tested under pressure to ensure tight shutoff.

## 2.9 VRF SYSTEM CONTROL CABLE

A. General Requirements: Refer to and verify all wire and cabling requirements with the manufacturer's current installation and operation manuals to ensure compliance with the latest standards and specifications. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable.

B. Low-Voltage Control Network Cabling:

1. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   a. Shielded wire (2-core) 16 AWG—CVVS, CPEVS or MVVS.
   b. PVC insulation and jacket.
   c. Foil shielded.
   d. Flame Resistance: Comply with NFPA 262.
   e. Maximum cable distance (distance to farthest components) is **1,640 feet**.
   f. Maximum cable distance from OU to connected IU is **656 feet**.
   g. Maximum total cable length (sum of all network cabling) is **6,560 feet**.

C. Low-Voltage Wall-Mounted Controller Cabling to Indoor Units:

1. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   a. 22 AWG, 2-conductor unshielded 7-stranded bare copper wire.
      1) Residential / multi-family style controllers require 4-conductor.
      2) Touch controllers with integral occupancy and light sensing controllers require low-voltage control network cabling to the network.
   b. PVC insulation and jacket.
   c. Flame Resistance: Comply with NFPA 262.
   d. Maximum cable distance (distance from controller to indoor unit) varies by controller style. Refer to manufacturer Submittal or Installation Guides.

D. Transmission power booster provided if additional signal power is required based on connected devices. Coordinate with VRF manufacturer and install near middle of communication bus when required.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the

Work.

B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.

D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.

E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.

F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.

G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION, GENERAL

A. Clearance:

1. Maintain manufacturer's recommended clearances for service and maintenance.
2. Maintain clearances required by governing code.

B. Equipment Restraint Installation: Install equipment with seismic-restraint device. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 INSTALLATION OF INDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of **3/8 inch**

C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.

D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.

E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.

F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.

G. Provide lateral bracing if needed to limit movement of suspended units to not more than [**0.25 inch**

## 3.4 INSTALLATION OF OUTDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Install outdoor units on support structures indicated on Drawings.

C. Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

1. Attachment: Install anchor bolts to elevations required for proper attachment to supported equipment.
2. Grouting: Place grout under equipment supports and make bearing surface smooth.

## 3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping and tubing to permit valve servicing.

F. Install piping and tubing at indicated slopes.

G. Install piping and tubing free of sags.

H. Install fittings for changes in direction and branch connections.

I. Install piping and tubing to allow application of insulation.

J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.

K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

L. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

## 3.6 INSTALLATION OF SYSTEM CONDENSATE DRAIN PIPING

A. General Requirements for Drain Piping and Tubing:

1. Install a union in piping at each threaded unit connection.

B. Gravity Drains:

1. Slope piping from unit connection toward drain termination at a constant slope of not less than one percent.

## 3.7 INSTALLATION OF REFRIGERANT PIPING

A. Refrigerant Tubing Kits:

1. Unroll and straighten tubing to suit installation. Deviations in straightness of exposed tubing shall be unnoticeable to observer.
2. Support tubing as specified in Section 230516 “Hangers and Supports for HVAC Piping and Equipment.”
3. Prepare tubing ends and make mating connections to provide a pressure tight and leak-free installation.

B. Select system components with minimum **650 psig** pressure rating.

C. Install piping as short and direct as possible, with a minimum number of joints and fittings.

D. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

E. Install refrigerant piping and tubing in protective conduit where installed below ground.

F. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.

G. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:

1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Traps to entrain oil in vertical runs are not allowed.
4. Inverted traps for twinned systems may be required by manufacturer.
5. Liquid lines may be installed level.

H. When brazing, remove or protect components that could be damaged by heat. Braze pipes with a dry nitrogen purge to avoid oxidation.

I. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.

J. Joint Construction:

1. Brazed Joints
   a. Ream ends of tubes and remove burrs.
   b. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.
   c. Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
   d. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.
   e. The piping being brazed shall be purged of air to remove the oxygen and filled with one of the following inert gases: oxygen-free nitrogen, helium or argon.

The piping system shall be purged with an inert gas for a minimum time corresponding to five volume changes through the piping system prior to brazing. The pre-purge rate shall be at a minimum velocity of 100 feet per minute (0.508 m/s). The inert gas shall be directly connected to the tube system being brazed to prevent the entrainment of ambient air. After the pre-purge, the inert gas supply shall be maintained through the piping during the brazing operation at a minimum pressure of **1.0 psi** (**6.89 kPa**) and a maximum pressure of **3.0 psi** (**20.67 kPa**). The joint shall be brazed with a filler metal conforming to AWS A5.8

2. Flared Joints
   a. Flared fittings shall be installed in accordance with the manufacturer's instructions. The flared fitting shall be used with the tube material specified by the fitting manufacturer. The flared tube end shall be made by a tool designed for that operation.
3. Soldered Joints
   a. Use of soldered joints is prohibited within VRF systems.

## 3.8 INSTALLATION OF PIPING AND TUBING INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated. Installation to maintain a continuous vapor barrier.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are unavailable, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Where PVC jackets are indicated, install with **1-inch (25-mm)** overlap at longitudinal seams and end joints, for horizontal applications. Seal with manufacturer's recommended adhesive.

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

E. Where metal jackets are indicated, install with **2-inch (50-mm)** overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands **12 inches (300 mm)** o.c. and at end joints.

## 3.9 INSTALLATION OF DUCT AND ACCESSORIES

A. Where installing ductwork adjacent to equipment, allow space for service and maintenance.

B. Comply with requirements for metal ducts specified in other Division 23 sections.

C. Comply with requirements for air duct accessories specified in other Division 23 sections.

## 3.10 IDENTIFICATION

A. Identify system equipment, piping, tubing, and valves. Comply with requirements for identification specified in other Division 23 sections.

## 3.11 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.

1. Field service shall be performed by a manufacturer-trained and authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.
2. Manufacturer-trained and authorized service representative shall provide on-site visits during construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.
   a. First Visit: Kick-off meeting.
   b. Second Visit: At approximately [**25**] percent completion of system(s).
   c. Third Visit: At approximately [**50**] percent completion of system(s).
   d. Fourth Visit: At approximately [**75**] percent completion of system(s).
   e. Fifth Visit: Final inspection before system startup.
3. Kick-off Meeting:
   a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.
   b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.
   c. Meeting shall cover the following as a minimum requirement:
      1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.
      2) Manufacturer's installation requirements specific to systems being installed.
      3) Review of all relevant VRF HVAC system submittals, including delegated-design submittals.
      4) Required field activities related installation of VRF HVAC system.
      5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.
4. Site Visits: Activities for each site visit shall include the following:
   a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.
   b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.
   c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.
   d. Advise and if necessary, assist Installer with updating related refrigerant calculations and system documentation.
5. Final Inspection before Startup:
   a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according to manufacturer's requirements and ready for final inspection.
   b. All system equipment and operating components shall be inspected. If

components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.

c. A factory-trained and authorized service representative shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.

d. Inspection reports for indoor units shall include, but not be limited to, the following:
   1) Unit designation on Drawings.
   2) Manufacturer model number.
   3) Serial number.
   4) Network address, if applicable.
   5) Each equipment setting.
   6) Mounting, supports, and restraints properly installed.
   7) Proper service clearance provided.
   8) Wiring and power connections correct.
   9) Line-voltage reading(s) within acceptable range.
   10) Wiring and controls connections correct.
   11) Low voltage reading(s) within an acceptable range.
   12) Controller type and model controlling unit.
   13) Controller location.
   14) Temperature settings and readings within an acceptable range.
   15) Condensate removal acceptable.
   16) Fan settings and readings within an acceptable range.
   17) Unit airflow direction within an acceptable range.
   18) If applicable, fan external static pressure setting.
   19) Filter type and condition acceptable.
   20) Noise level within an acceptable range.
   21) Refrigerant or hydronic piping properly connected and insulated.
   22) Condensate drain piping properly connected and insulated.
   23) If applicable, ductwork properly connected.
   24) If applicable, external interlocks properly connected.
   25) Remarks.

e. Inspection reports for outdoor units shall include, but not be limited to, the following:
   1) Unit designation on Drawings.
   2) Manufacturer model number.
   3) Serial number.
   4) Network address, if applicable.
   5) Each equipment setting, including compressor speed control.
   6) Mounting, supports, and restraints properly installed.
   7) Proper service clearance provided.
   8) Wiring and power connections correct.
   9) Line-voltage reading(s) within acceptable range.
   10) Wiring and controls connections correct.
   11) Low voltage reading(s) within an acceptable range.
   12) Condensate removal acceptable.
   13) Noise level within an acceptable range.
   14) Refrigerant piping properly connected and insulated.
   15) Condensate drain piping properly connected and insulated.
   16) For water-source outdoor units, water piping properly connected and insulated.
   17) For water-source outdoor units, proof of water flow checked for proper

operation.
18) Remarks.

f. Installer shall provide manufacturer with the requested documentation including as-built piping lengths and technical support during inspection.
g. Installer shall correct observed deficiencies found by the inspection.
h. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.
i. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved, and systems are deemed ready for startup.
j. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: Not less than 24 hours after electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing installation, pressurize tubing systems to a test pressure:
   a. Refrigerant piping to a test pressure of not less than **600 psig** using dry nitrogen.
   b. Hydronic piping to a test pressure of not less than **43 psig**.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.
4. Prepare test report to record the following information for each test:
   a. Name of person starting test, company name, phone number, and e-mail address.
   b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
   c. Detailed description of extent of tubing tested.
   d. Date and time at start of test.
   e. Test pressure at start of test.
   f. Outdoor temperature at start of test.
   g. Name of person ending test, company name, phone number, and e-mail address.
   h. Date and time at end of test.
   i. Test pressure at end of test.
   j. Outdoor temperature at end of test.
   k. Remarks:
5. Submit test reports for Project record and to system manufacturer.

D. Refrigerant Tubing Evacuation Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500 microns.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of one hour with no change.
4. Prepare test report to record the following information for each test:
   a. Name of person starting test, company name, phone number, and e-mail address.
   b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
   c. Detailed description of extent of tubing tested.
   d. Date and time at start of test.
   e. Test pressure at start of test.
   f. Outdoor temperature at start of test.
   g. Name of person ending test, company name, phone number, and e-mail address.
   h. Date and time at end of test.
   i. Test pressure at end of test.
   j. Outdoor temperature at end of test.
   k. Remarks:
5. Submit test reports for Project record and to system manufacturer.
6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.

E. System Refrigerant Charge:

1. System Installer shall consult system manufacturer to determine the correct system refrigerant charge based on as-built piping lengths.
2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
3. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

## 3.12 STARTUP SERVICE

A. Installer shall engage a factory-trained and authorized service representative of VRF HVAC system manufacturer to perform system(s) startup supervision.

1. Complete startup service of each separate system.
2. Complete system startup service according to manufacturer's written instructions.

B. Startup checks shall include, but not be limited to, the following:

1. Check control communications of equipment and each operating component in system(s).
2. Check each outdoor unit’s power supply is connected 12 to 24 hours before startup of system.
3. Check each indoor unit's response to demand for cooling and heating.
4. Check each indoor unit's response to changes in airflow settings.
5. Check each indoor unit and outdoor unit for proper condensate removal.

C. Installer shall accompany factory-trained and authorized service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.

1. Installer shall correct deficiencies found during startup service for reverification.

D. System Operation Report:

1. After completion of startup service, manufacturer shall issue a report for each separate system.
2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
3. Manufacturer shall electronically record not less than one hour of continuous operation of each system and submit with report for historical reference.
   a. All available system operating parameters shall be included in the information submitted.

E. Witness:

1. Invite Architect, Owner, and, Commissioning Agent to witness startup service procedures.
2. Provide written notice not less than 20 business days before start of startup service.

## 3.13 ADJUSTING

A. Adjust equipment and components to function smoothly and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points. Adjust initial airflow settings and discharge airflow patterns.

C. Set field-adjustable switches according to VRF HVAC system manufacturer's written instructions, and as indicated.

## 3.14 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include [12] months' full maintenance by skilled employees of system Installer who are manufacturer's authorized service representative]. Include four service visits for preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment and system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

## 3.15 DEMONSTRATION

A. Engage a VRF HVAC system manufacturer's factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.

B. Instructor:

1. Instructor shall be factory trained and certified by VRF HVAC system manufacturer with current training on the system(s), equipment, and controls that are installed.

C. Schedule:

1. Schedule training with Owner at least 10 business days before first training session.
2. Training shall occur before Owner occupancy.
3. Training shall be held at mutually agreed date and time during normal business hours.

D. Location: Owner shall provide a suitable on-site location to host classroom training.

E. Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee's name, signature, phone number, and e-mail address.

F. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.

G. Training Materials: Provide training materials in electronic format to each attendee.

1. Offer online instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.

H. Acceptance: Obtain Commissioning Agent, and Owner written acceptance that training is complete, and requirements indicated have been satisfied.

END OF SECTION 238130

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## SECTION 260500 - ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

The Electrical General Requirements are supplementing and applicable to Division 26 Sections and shall apply to all phases of work specified herein, shown on the Drawings, or required to provide a complete installation of electrical systems. Section 26 is sub-divided for convenience only.

A. This Section includes the following:

1. Job Conditions
2. Regulatory Requirements
3. Electrical equipment coordination and installation.
4. Submittals, Operating and Maintenance instructions and As-built drawings.
5. Common electrical installation requirements.
6. Warranty of work.

1.2 JOB CONDITIONS:

A. Site Inspections: Before submitting proposals, each bidder should visit the site and fully familiarize himself with all job conditions and shall be fully informed as to the extent of his work. No consideration will be given after bid opening date for alleged misunderstanding as to the requirements of work involved in connecting to the utilities or as to requirements of materials to be furnished. The contractor shall contact the utility prior to bid and make appropriate provisions in such bid as required by the utility for the utility's routing and connection.

B. Scheduled Interruptions: Planned interruptions of utilities service, to any facility affected by this contract, shall be carefully planned and approved by Architect at least ten (10) days in advance of the requested interruption. The Contractor shall not interrupt services until the Architect has granted specific approval. The request shall indicate services to be affected, date and time of interruption and duration of outage. Request for interruption of service will not be approved until all equipment and materials required for the completion of that particular phase of work are on the job site. The work may have to be scheduled after normal working hours.

C. Accidental Interruptions: All excavation and/or remodeling work required shall be performed with care so as not to interrupt other existing services (water, gas, electrical, sewer, sprinklers, etc.). If accidental utility interruption resulting from work performed by the Contractor occurs, service shall be immediately restored to its original condition without delay, by and at the expense of the Contractor, using skilled workmen of the trade required.

1.3 REGULATORY REQUIREMENTS:

A. Permits, Fees, and Inspections: This Contractor shall secure and pay for all permits, and inspections required on work performed under this section of the Specifications. He shall assume full responsibility for all assessments and taxes necessary for the completion and acceptance of the work.

B. Applicable Standards and Codes: The electrical installation shall comply with all applicable building codes; local, state, and federal ordinances. In case of a discrepancy among these applicable regulatory codes and ordinances, the most stringent requirement shall govern. The Contractor shall notify the Architect in writing of any such discrepancy. Should the Contractor perform any work that does not comply with the applicable regulatory codes and ordinances he shall bear all cost arising in

correcting the deficiencies. Application standards and codes shall include all local ordinances, all state laws, and the applicable requirements of the following:

1. American National Standards Institute - ANSI
2. National Electrical Manufacturer's Association - NEMA
3. National Fire Protection Association – NFPA (latest editions)
4. The National Electric Code – NEC – NFPA 70, 2020
5. The Life Safety Code – NFPA 101, 2021
6. The National Fire Alarm Code – NFPA 72, 2019
7. Florida Building Code, 2023 Edition
8. Underwriters' Laboratories, Inc. – UL

C. Drawings and Specifications: The drawings and these specifications are complementary each to the other. What is called for by one shall be as binding as if called for by both. Omissions from the drawings and specifications of details of work which are evidently necessary to carry out the intent of the drawings and specifications, or which are customarily performed, shall not relieve the Contractor from performing such work. In any case of discrepancy in the figures or catalog numbers, the matter shall be submitted to the Architect, who shall promptly make a determination in writing. Any adjustment by the Contractor shall be at the Contractor's own risk and expense. Electrical drawings are diagrammatic only. Do not scale these drawings. All equipment shall be installed in accordance with manufacturer's recommendations and any conflicting data shall be verified before bidding.

D. The Contractor shall after completion of the work, furnish the Architect a certificate of final inspection and approval from the applicable local inspection department. The Contractor shall also make necessary changes to plans and specifications to meet code standards at no additional cost to the Owner.

1.4 CONNECTION TO EXISTING UTILITIES:

A. All utility work shall be coordinated with and approved by the local providing utility. Permission for all utility outages shall be requested a minimum of (10) days in advance unless an emergency arises. Explicit detail shall be shown for all connections to existing utilities. The applicable utility company must approve both the location and the method of the proposed connection.

B. The contractor shall coordinate procedure to, and shall pay for, all electric energy consumption during construction as part of the project.

C. The contractor shall include the electric utility connection fee in the bid unless specifically directed by Owner not to do so. If, prior to bid, the electric utility connection fee is unknown, the Contractor shall include $25,000 as a line item in the bid for each service. Once the utility connection fee is known, if the utility connection fee is less than $25,000, the balance shall be removed from the Contractor's total contract price.

1.5 COOPERATION:

A. Interfacing with Other Crafts: It shall be the responsibility of the Contractor to cooperate and coordinate with all other crafts working on this project. This Contractor shall do all cutting, trenching, backfill and structural removals to permit entry of the electrical system components. The General Contractor shall do all patching and finishing.

B. Equipment Furnished Under Other Sections: This Contractor shall furnish and install, complete electrical roughing-in and connections to all equipment furnished under other sections and indicate on

drawings. This includes all outlets as shown on mechanical and electrical drawings. All such equipment shall be set in place as work of other sections.

C. Heating and Air Conditioning:

1. The Contractor shall furnish all branch circuit wiring to motors and control panels or centers including disconnects, receptacles, switches, and appurtenances to which the system at the units may be connected, to provide a complete system of wiring for power. Control equipment and control circuit wiring is specified in the Mechanical Section.

2. Control devices to be included in the branch circuit, except those furnished integrals with the equipment, will be delivered by the Heating and Air Conditioning Contractor and installed by the Electrical Contractor.

1.6 WORKMANSHIP:

All work shall be executed in a neat and substantial manner by skilled workman, well qualified, and regularly engaged in the type of work required. Substandard work shall be removed and replaced by the Contractor at no cost to the Owner.

1.7 APPROVAL OF MATERIALS AND EQUIPMENT:

Prior-Submittals: The Contractor shall base his proposal on the materials specified herein and on the drawings. Reference to a particular product by manufacturer, trade name, or catalog number establishes the quality standards of material and equipment required for this installation and is not intended to exclude products equal in quality and similar design. The Specifying Engineer reserves the sole right to decide the equality of materials proposed for use in lieu of these specified. It shall be the Contractor's responsibility to furnish the information and data sufficient to establish the quality and utility of the items in question, including furnishing of samples if required. If other equipment manufacturers determine that their equipment will fit in the space and meet the recommended clearances, suit all job conditions, equal or exceed the quality of the specified items, then a request may be made in writing to the Specifying Engineer at least ten (10) business days prior to bid date for permission to be included in the approved equipment list. All data required for evaluation shall accompany the above letter. The Specifying Engineer offers two submittal reviews, if these are unacceptable, only an “as-specified” submittal will be accepted. In addition, all value engineering alternates should only be submitted when directly requested by the owner and must be noted specifically as “VE” alternates to the items specified in the construction documents. A letter from the owner directing the VE effort is strongly encouraged as an accompaniment to any VE submittal.

A. Submittals:

1. Submittals: The Contractor shall submit a list of equipment proposed for installation. Catalog data and shop drawings on all proposed systems and their components shall be submitted. Where substitutions alter the design or space requirements, the Contractor shall defray all items of cost for the revised design and construction including costs to all allied trades involved. Provide six (6) copies of submittals and shop drawings as a minimum unless the General Conditions requires a greater number of copies. In lieu of paper copies, the Contractor may submit the submittals in PDF format.
   a. Submittals Schedule: Submittals shall be submitted within thirty (30) days after the contract is awarded. It is not the responsibility of the Engineer to expedite the review of submittals if the contractor has not adequately prepared the submittals in a time efficient manner. The contractor bears all the responsibility for the added time requirements of resubmittals.

b. Identification: Place a permanent label or title block on each submittal for identification. Each major section of submittals such as power equipment, lighting equipment, fire alarm, etc., shall be secured together in a booklet or stapled with a covering index. The different parts of the submittal shall describe which Specification Section it is referenced. The covering index shall list the following information:
   1) Project name and date
   2) Name, address, and phone number of General contractor and project manager.
   3) Name, address, and phone number of Sub-contractor and project manager.
   4) Supplier of equipment with phone number and person responsible for this project.
   5) Index of each item covered in submittal and model number.
   6) Any deviation from contract documents shall be specifically noted on submittal cover index and specifically identified with highlighting, encircling, or boldly on specific submittal sheet.

c. The submittal shall not be in individual parts per each Specification Section but be combined as a part of a major section such as power equipment, lighting equipment, fire alarm, methods, etc.

d. Resubmittals: The Specifying Engineer will participate in two resubmittal reviews. After the second resubmittal review, the Engineer shall not review the submittal until the Contractor provides $1,000 to the Engineer to perform each additional required resubmittal review. Make resubmittals in same form and number of copies as initial submittal.
   1) Include previous submittal review comments.
   2) For each item being resubmitted, include previous review comment and explain how resubmitted item meets the criteria of the previous review comment.

2. Electrical and Mechanical/Plumbing/Fire Protection Equipment Coordination:

The electrical power equipment submittals shall be accompanied by a letter verifying coordination of electrical services for all mechanical, plumbing, and fire protection equipment requiring power. The letter shall follow the format listed below.

To: _____
(General Contractor)

Re: _____
(Project name and location)

We the undersigned subcontractors certify that we have coordinated the electrical requirements for mechanical, plumbing, and fire protection sprinkler equipment as evidenced by the coordination chart listed herein.

| Item | Load Full Load Amps | 1 Phase or 3 Phase | Number of Electrical Connections | Maximum Overcurrent Protection | Minimum Overcurrent Protection | Breaker Proposed | Circuit Proposed |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

The above list details all required electrical connections for mechanical equipment.

Signed: _____

For: _____
Mechanical Subcontractor

The above list details all required electrical connections for plumbing equipment.

Signed: _____

For: _____
Plumbing Subcontractor

The above list details all required electrical and fire alarm connections for fire protection equipment.

Signed: _____

For: _____
Fire Protection Sprinkler Subcontractor

The above list of equipment has been reviewed and the required connections are being provided. (Any exceptions or request for direction shall be listed here)

Signed: _____

For: _____
Electrical Subcontractor

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protection: Take necessary precautions to protect all material, equipment, apparatus, and work from damage. Failure to do so to the satisfaction of the Architect will be sufficient cause for the rejection of the material, equipment, or work in question. Contractor is responsible for the safety and good condition of the materials installed until final acceptance by the owner.

B. Cleaning: Conduit openings shall be capped or plugged during installation. Fixtures and equipment shall be tightly covered and protected against dirt, moisture, chemical and mechanical injury. At the completion of the work the fixtures, material and equipment shall be thoroughly cleaned and delivered in condition satisfactory to the Architect.

1.9 TESTING AND BALANCING:

Make tests that may be required by the Owner or the Architect in connection with the operation of the electrical system in the buildings. Verify phase rotation of electrical system and that voltages are within acceptable limits. Balance all single-phase loads connected to all panelboards in the buildings to insure approximate equal divisions of these loads on the main secondary power supply serving the buildings. All tests shall be made in accordance with the latest standards of the IEEE and the NEC. The installation shall be tested as defined in the 26 specifications. Contractor shall perform circuit continuity and operational tests on all equipment furnished or connected by Contractor. The tests shall be made in the presence of the Architect or his representative. The Contractor shall notify the Architect at least twenty-four (24) hours in advance of tests. The Contractor shall provide all testing equipment and all costs shall be borne by him. Written reports shall be made of all tests and shall be made available at the Pre-Final Inspection. All faults shall be corrected immediately.

A. A letter shall be written giving the following:

1. Measured amps on each phase of each panel.
2. Resistance to ground of each new grounding electrode.
3. Measured voltage phase to phase and phase to neutral at each panel.
4. Ground continuity and polarity instrument used.

1.10 OPERATING AND MAINTENANCE INSTRUCTIONS/AS BUILT DRAWINGS:

A. Four (4) complete sets of instructions containing the manufacturer's Operating and Maintenance (O&M) instructions for each piece of equipment shall be furnished to the Owner. Each set shall be permanently bound and shall have a hard cover. One complete set shall be furnished at the time that the test procedure is submitted, and remaining sets shall be furnished before the Contract is completed. Flysheets shall be placed before instructions covering each subject. The instruction sheets shall be approximately 8-1/2" by 11" with large sheets of Drawings folded in. The instructions shall include information for major pieces of equipment and systems. In addition, a CD shall be provided to the Owner with the O&M Manuals and Drawings contained therein.

B. This Contractor shall provide as-built Drawings at the completion of the job. Drawings shall show all significant changes in equipment, wiring, routing, location, etc. All underground conduit routing shall be accurately indicated with locations dimensioned. As-built drawings shall be submitted for review as red-lined on a field hard copy (digitally edited PDF documents are also acceptable).

C. All signals, communications, data, control, dimming systems, etc. shall be included in the As-Built drawings. Where electrical drawings contain a large number of items that prevent easy discernment of the As-Built system, enlarged details or other graphic methods shall be used to clarify the identification required for As-Builts usage.

D. As-Built drawings shall include the following information:

1. Stub-out locations dimensioned from permanent building lines.
2. Routing of all main feeders and identified as under slab, in slab, above ceiling, etc. also for lighting and power branch circuits the number of conductors shall be included, and for feeders and motor branch circuits the number, size, and insulation of conductors shall be included.
3. Corrected panel board and equipment schedules.
4. Corrected circuit numbers as they appear on the panel board directories.
5. Corrected motor horsepower and full load amperes.
6. Location of major distribution open junction boxes with 2" conduit and over.
7. Location of all underground raceways or duct banks dimensioned from easily identified points with depth indicated from BFG (below finished grade) and by elevation in feet.

1.11 GUARANTEE AND SERVICE:

A. Upon completion of all tests and acceptance, the Contractor shall furnish the Owner a written guarantee covering the electrical work done for a period of one (1) year from date of acceptance. Guarantee includes equipment capacity and performance ratings specified without excessive noise levels. Upon notice from the Architect or the Owner, the Contractor shall, during the guarantee period, rectify and replace any defective material or workmanship and repair any damage caused thereby without additional cost.

## PART 2 - EXECUTION

### 2.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1-2015.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to raceways and piping systems installed at a required slope.

**END OF SECTION 260500**

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# SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Aluminum building wire rated 600 V or less.
3. Metal-clad cable, Type MC, rated 600 V or less.
4. Fire-alarm wire and cable.
5. Connectors, splices, and terminations rated 600 V and less.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

### 1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

## PART 2 - PRODUCTS

### 2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated, and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

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

1. Alpha Wire Company.
2. General Cable Technologies Corporation.
3. Okonite Company (The).
4. Southwire Company.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

1. Type NM: Comply with UL 83 and UL 719. (Romex – inside Dwelling Units Only)
2. Type RHH and Type RHW-2: Comply with UL 44.
3. Type USE-2 and Type SE: Comply with UL 854.
4. Type THHN and Type THWN-2: Comply with UL 83.
5. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
6. Type XHHW-2: Comply with UL 44.

## 2.2 ALUMINUM BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Allowed Use Locations: Aluminum conductors may only be used on feeder or distribution circuits larger than 100A. The Drawings typically indicate all conductor sizes in copper. The contractor shall provide a cross reference table for engineer approval prior to any conductor to be substituted with an aluminum conductor.

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

1. Alpha Wire Company.
2. General Cable Technologies Corporation.
3. Okonite Company (The).
4. Southwire Company.

D. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

E. Conductors: Aluminum, complying with ASTM B800 and ASTM B801.

1. Type NM: Comply with UL 83 and UL 719. (Romex – inside Dwelling Units Only)
2. Type RHH and Type RHW-2: Comply with UL 44.
3. Type USE-2 and Type SE: Comply with UL 854.
4. Type THHN and Type THWN-2: Comply with UL 83.
5. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
6. Type XHHW-2: Comply with UL 44.

## 2.3 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Allowed Use Locations: Metal-clad cable, Type MC shall only be used in walls from end of circuit devices (receptacles or switches) up to junction box above ceiling for homerun circuit or

light fixture. Homerun circuit shall not be in Type MC cable. Wiring between devices within walls are allowed to be in Type MC cable.

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

1. General Cable Technologies Corporation.
2. Okonite Company (The).
3. Southwire Company.

D. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. RoHS compliant.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

E. Circuits:

1. Single circuit.

F. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

G. Ground Conductor: Insulated.

H. Conductor Insulation:

1. Type TFN/THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

I. Armor: Steel, interlocked.

J. Jacket: PVC applied over armor.

## 2.4 FIRE-ALARM WIRE AND CABLE

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

1. General Cable Technologies Corporation.
2. Okonite Company (The).
3. Southwire Company.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 16 AWG.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.

## 2.5 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc diecast with set screws, designed to connect conductors specified in this Section.

# PART 3 - EXECUTION

## 3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper for feeders smaller than No. 3 AWG; copper or aluminum for feeders No. 3 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

## 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

C. Feeders Concealed in Ceilings and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

D. Feeders Concealed in Walls and Partitions: Type THHN/THWN-2, single conductors in raceway.

E. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

F. Feeders in Cable Tray: Type THHN/THWN-2, single conductors in raceway or Type RHW-2/USE-2 if exterior located.

G. Exposed Branch Circuits, Including in Crawlspaces: Type XHHW-2, single conductors in raceway.

H. Dwelling Unit only - Branch Circuits Concealed in Ceilings, Walls, and Partitions: Nonmetallic-sheathed cable, Type NM

I. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

J. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

## 3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

F. Support cables according as required by other Specification sections."

## 3.4 INSTALLATION OF FIRE-ALARM WIRING

A. Comply with NECA 1 and NFPA 72.

B. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

D. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

E. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

## 3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

D. Prior to conduit/conductor routing to outlets, contractor shall request final verification of locations. Outlets shall be allowed to be moved 10 feet prior to installation with no cost change.

E. Comply with requirements in accompanying Section on Fire Alarm Systems for connecting, terminating, and identifying wires and cables.

## 3.6 IDENTIFICATION

A. Identify and color-code conductors and cables according to requirements in accompanying Sections in this book of Specifications.

B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

## 3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in accompanying Sections in this book of Specifications.

## 3.8 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to requirements in accompanying Sections in this book of Specifications.

**END OF SECTION 260519**

# SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Balanced twisted pair cabling hardware.
2. RS-485 cabling.
3. Low-voltage control cabling.
4. Control-circuit conductors.

### 1.2 DEFINITIONS

A. 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.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

### 1.4 QUALITY ASSURANCE

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inches or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

E. RoHS compliant.

## 2.2 BALANCED TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.

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

1. AMP NETCONNECT; a TE Connectivity Ltd. company.
2. Belden CDT Networking Division/NORDX.
3. General Cable; General Cable Corporation.
4. Hubbell Premise Wiring.
5. Siemon Co. (The).
6. Superior Essex Inc.

C. General Requirements for Balanced Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 5e and/or Category 6 as applicable to product used.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

D. Connecting Blocks: 110-style IDC for Category 5e or Category 6 as applicable Provide blocks for the number of cables terminated on the block, plus 20 percent spare, integral with connector bodies, including plugs and jacks where indicated.

E. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.
d. 12, 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19-inch equipment racks or on wall-mountable independent of an equipment rack.

F. Patch Cords: Factory-made, four-pair cables in lengths necessary to connect equipment or as indicated on the Drawings; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant and color-coded boots to ensure performance. Patch cords shall have latch guards to protect against snagging.

G. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.
2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.
3. Marked to indicate transmission performance.

H. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standards.

    a. Category 5e, unshielded balanced twisted pair cable shall comply with IEC 60603-7-2.
    b. Category 5e, shielded balanced twisted pair cable shall comply with IEC 60603-7-3.
    c. Category 6, unshielded balanced twisted pair cable shall comply with IEC 60603-7-4.
    d. Category 6, shielded balanced twisted pair cable shall comply with IEC 60603-7.5.

4. Marked to indicate transmission performance.

I. Faceplate:

1. Port quantity as indicated on the Drawings; vertical single gang faceplates designed to mount to single gang wall boxes.
2. Plastic Faceplate: High-impact plastic. Coordinate color with Drawings and Architect
3. Metal Faceplate: Stainless steel, complying with requirements in "Wiring Devices."
4. For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.

    a. Flush mounting jacks, positioning the cord at a 45-degree angle.

J. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

## 2.3 TWIN-AXIAL DATA HIGHWAY CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, One pair or as noted on Drawings, No. 18 AWG, stranded (7x32) tinned-copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

## 2.4 RS-232 CABLE

A. PVC-Jacketed, TIA 232-F:

1. Nine, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Polypropylene insulation.
3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
4. PVC jacket.

5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. NFPA 70 Type: Type CM.
7. Flame Resistance: Comply with UL 1581.

B. Plenum-Type, TIA 232-F:

1. Nine, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. PE insulation.
3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
4. Fluorinated ethylene propylene jacket.
5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

## 2.5 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262.

## 2.6 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. Multi-pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

## 2.7 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

B. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

D. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

1. Smoke control signaling and control circuits.

## 2.8 FIRE-ALARM WIRE AND CABLE

A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

## 2.9 SOURCE QUALITY CONTROL

A. Factory test balanced twisted pair cables according to TIA-568-C.2.

B. Cable will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Test balanced twisted pair cables on receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

## 3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

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. Flexible metal conduit shall not be used.

B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the room from overhead.
4. Extend conduits 4 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

## 3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lay on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in "Communications Copper Horizontal Cabling" unless otherwise indicated.
3. Do not untwist UTP cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways or j-hooks with plenum rated cabling. Comply with requirements specified in "Raceways and Boxes for Electrical Systems."

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. 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. Below each feed point, neatly coil a minimum of 72 inches of cable in a coil not less than 18 inches in diameter.

## 3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

## 3.5 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.

## 3.6 FIRESTOPPING

A. Comply with TIA-569-D, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping" Chapter.

## 3.7 GROUNDING

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control wiring and cabling, comply with requirements "Grounding and Bonding for Electrical Systems."

## 3.8 IDENTIFICATION

A. Comply with requirements for identification specified in "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

## 3.9 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect 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-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment, and patch cords, and labeling of all components.

B. End-to-end cabling will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

**END OF SECTION 260523**

# SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes grounding and bonding systems and equipment.

B. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Ground bonding common with lightning protection system.
3. Foundation steel electrodes.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

### 1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article.

B. Field quality-control reports.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1. Plans showing as-built, dimensioned locations of system described in "Field Quality Control" Article, including the following:

a. Test wells.
b. Ground rods.
c. Ground rings.
d. Grounding arrangements and connections for separately derived systems.

2. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems.

a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
b. Include recommended testing intervals.

## 1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by NETA.

# PART 2 - PRODUCTS

## 2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

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

## 2.2 MANUFACTURERS

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

1. Burndy; Part of Hubbell Electrical Systems.
2. ERICO; a brand of nVent.
3. Galvan Industries, Inc.; Electrical Products Division, LLC.
4. O-Z/Gedney; a brand of Emerson Industrial Automation.
5. Thomas & Betts Corporation; A Member of the ABB Group.

## 2.3 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

## 2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.

D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

G. Conduit Hubs: Mechanical type, terminal with threaded hub.

D. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

E. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

F. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

G. Straps: Solid copper, copper lugs. Rated for 600 A.

H. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

I. Water Pipe Clamps:

1. Mechanical type, two pieces with stainless-steel bolts.

    a. Material: Die-cast zinc alloy.
    b. Listed for direct burial.

2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

## 2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet.

B. Ground Plates: 1/4 inch thick, hot dip galvanized.

# PART 3 - EXECUTION

## 3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger unless otherwise indicated.

B. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

## 3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

## 3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

B. Dry-type Transformer: Install a main bonding jumper between the neutral and ground buses inside of the transformer enclosure. Connect transformer ground to building grounding electrode system. Provide supply side bonding jumper from the transformer ground to the first panel supplied from the transformer secondary terminals.

## 3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with

substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

## 3.5 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

## 3.6 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. Use exothermic welds for all below-grade connections.

3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

I. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

J. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

## 3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohms.
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

**END OF SECTI**

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# SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Aluminum slotted support systems.
3. Conduit and cable support devices.
4. Support for conductors in vertical conduit.
5. Structural steel for fabricated supports and restraints.
6. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
7. Fabricated metal equipment support assemblies.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories.
b. Clamps.
c. Hangers.
d. Sockets.
e. Eye nuts.
f. Fasteners.
g. Anchors.
h. Saddles.
i. Brackets.

2. Include rated capacities and furnished specialties and accessories.

## PART 2 - PRODUCTS

### 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Manufacturers: Subject to compliance with requirements, undefined:

    a. Allied Tube & Conduit; a part of Atkore International.
    b. B-line, an Eaton business.
    c. Thomas & Betts Corporation; A Member of the ABB Group.
    d. Unistrut; Part of Atkore International.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Material for Channel, Fittings, and Accessories: Galvanized steel.
4. Channel Width: Selected for applicable load criteria.
5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Manufacturers: Subject to compliance with requirements, undefined:

    a. Cooper Industries, Inc.
    b. Thomas & Betts Corporation; A Member of the ABB Group.
    c. Unistrut; Part of Atkore International.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Channel Material: 6063-T5 aluminum alloy.
4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
5. Channel Width: Selected for applicable load criteria.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported. Cable-ties shall be of the Type 2S or Type 21S per NEC 330.30(A).

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

    a. Manufacturers: Subject to compliance with requirements, undefined:
        1) Hilti, Inc.
        2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.

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

    a. Manufacturers: Subject to compliance with requirements, undefined:
        1) B-line, an Eaton business.
        2) Hilti, Inc.
        3) ITW Ramset/Red Head; Illinois Tool Works, Inc.
        4) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F 3125/F 3125M, Grade A325.
6. Hanger Rods: Threaded steel.

## 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

# PART 3 - EXECUTION

## 3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

    1) NECA 1.
    2) NECA 101
    3) NECA 102.
    4) NECA 105.
    5) NECA 111.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slottedsupport system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

## 3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT IMC and RMC may be supported by openings through structure members, according to NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb .

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

## 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

## 3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000 psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:

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

**END OF SECTION 260529**

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# SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Boxes, enclosures, and cabinets.
5. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. "Penetration Firestopping" for firestopping at conduit and box entrances.
2. "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
3. "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

### 1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

### 1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:

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

    a. Allied Tube & Conduit; a part of Atkore International.
    b. O-Z/Gedney; a brand of Emerson Industrial Automation.
    c. Southwire Company.
    d. Thomas & Betts Corporation; A Member of the ABB Group.
    e. Wheatland Tube Company.

2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. GRC: Comply with ANSI C80.1 and UL 6.
4. IMC: Comply with ANSI C80.6 and UL 1242.
5. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

    a. Comply with NEMA RN 1.
    b. Coating Thickness: 0.040 inch, minimum.
6. EMT: Comply with ANSI C80.3 and UL 797.
7. FMC: Comply with UL 1; zinc-coated steel.
8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:

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

    a. Allied Tube & Conduit; a part of Atkore International.
    b. O-Z/Gedney; a brand of Emerson Industrial Automation.
    c. Southwire Company.
    d. Thomas & Betts Corporation; A Member of the ABB Group.
    e. Wheatland Tube Company.

2. Comply with NEMA FB 1 and UL 514B.
3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Fittings, General: Listed and labeled for type of conduit, location, and use.
5. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
6. Fittings for EMT:

    a. Material: Steel.
    b. Type: Setscrew or compression.

7. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

8. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

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

    a. RACO; Hubbell.
    b. Thomas & Betts Corporation; A Member of the ABB Group.
    c. United Fiberglass.

2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Fiberglass:

    a. Comply with NEMA TC 14.
    b. Comply with UL 2515 for aboveground raceways.
    c. Comply with UL 2420 for belowground raceways.

4. ENT: Comply with NEMA TC 13 and UL 1653.
5. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
6. LFNC: Comply with UL 1660.

B. Nonmetallic Fittings:

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

    a. RACO; Hubbell.
    b. Thomas & Betts Corporation; A Member of the ABB Group.
    c. United Fiberglass.

2. Fittings, General: Listed and labeled for type of conduit, location, and use.
3. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

    a. Fittings for LFNC: Comply with UL 514B.

4. Solvents and Adhesives: As recommended by conduit manufacturer.

## 2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

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

1. B-line, an Eaton business.
2. Hoffman; a brand of nVent.
3. MonoSystems, Inc.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 Type 3R unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

## 2.4 BOXES, ENCLOSURES, AND CABINETS

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

1. Crouse-Hinds, an Eaton business.
2. EGS/Appleton Electric.
3. Hoffman; a brand of nVent.
4. Hubbell Incorporated.
5. O-Z/Gedney; a brand of Emerson Industrial Automation.
6. RACO; Hubbell.
7. Thomas & Betts Corporation; A Member of the ABB Group.
8. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

E. Nonmetallic Floor Boxes: Nonadjustable, rectangular or round, as indicated on Drawings.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

J. Gangable boxes are allowed.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:

1. NEMA 250, Type 1 Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

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

a. Armorcast Products Company.
b. Oldcastle Enclosure Solutions.
c. Quazite: Hubbell Power Systems, Inc.

2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with closed bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC.".
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC IMC.
2. Concealed Conduit, Aboveground: GRC IMC EMT RNC, Type EPC-40-PVC.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried concrete encased.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFNC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: IMC. Raceway locations include the following:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.
    d. Gymnasiums.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: IMC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 1/2-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

## 3.2 INSTALLATION

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

D. Do not fasten conduits onto the bottom side of a metal deck roof.

E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

F. Complete raceway installation before starting conductor installation.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches of enclosures to which attached.

L. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to IMC before rising above floor.

M. Stub-Ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

S. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

T. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

V. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

W. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

X. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Conduit extending from interior to exterior of building.
4. Conduit extending into pressurized duct and equipment.
5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6. Where otherwise required by NFPA 70.

Y. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

Z. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

AA. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

CC. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

DD. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

EE. Locate boxes so that cover or plate will not span different building finishes.

FF. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

GG. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

HH. Set metal floor boxes level and flush with finished floor surface.

II. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

## 3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

## 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

## 3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

## 3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

## 3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

**END OF SECTION 260533**

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# SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
2. Rigid nonmetallic duct.
3. Flexible nonmetallic duct.
4. Duct accessories.
5. Precast concrete handholes.
6. Polymer concrete handholes and boxes with polymer concrete cover.
7. Fiberglass handholes and boxes with polymer concrete cover.
8. Fiberglass handholes and boxes.
9. High-density plastic boxes.
10. Precast manholes.
11. Cast-in-place manholes.
12. Utility structure accessories.

### 1.3 DEFINITIONS

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:

1. Two or more ducts installed in parallel, with or without additional casing materials.
2. Multiple duct banks.

D. GRC: Galvanized rigid (steel) conduit.

E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include duct-bank materials, including spacers and miscellaneous components.

2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Include accessories for manholes, handholes, and boxes.
4. Include underground-line warning tape.
5. Include warning planks.

B. Shop Drawings:

1. Precast or Factory-Fabricated Underground Utility Structures:

a. Include plans, elevations, sections, details, attachments to other work, and accessories.
b. Include duct entry provisions, including locations and duct sizes.
c. Include reinforcement details.
d. Include frame and cover design and manhole chimneys.
e. Include step details.
f. Include grounding details.
g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
h. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
b. Include duct entry provisions, including locations and duct sizes.
c. Include cover design.
d. Include grounding details.
e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

## 1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For duct and duct bank. Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

B. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.

C. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C858.

D. Source quality-control reports.

E. Field quality-control reports.

## 1.6 MAINTENANCE MATERIALS SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

1.8 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than ten days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Architect, Construction Manager, and Owner's written permission.

B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

C. Ground Water: Assume ground-water level is 36 inches (900 mm) below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

A. GRC: Comply with ANSI C80.1 and UL 6.

B. Coated Steel Conduit: PVC-coated GRC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

A. Underground Plastic Utilities Duct: Type EPC-80-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

B. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

C. Solvents and Adhesives: As recommended by conduit manufacturer.

## 2.3 FLEXIBLE NONMETALLIC DUCTS

A. HDPE Duct: Type EPEC-40 HDPE, complying with NEMA TC 7 and UL 651A.

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

## 2.4 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

C. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 75 mm) in size, manufactured from 6000-psi (41-MPa) concrete.

1. Color: Red dye added to concrete during batching.
2. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

## 2.5 PRECAST CONCRETE HANDHOLES AND BOXES

A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

B. Comply with ASTM C858 for design and manufacturing processes.

C. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

D. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

E. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.

1. Cover Hinges: Concealed, with hold-open ratchet assembly.
2. Cover Handle: Recessed.

F. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.

1. Cover Hinges: Concealed, with hold-open ratchet assembly.
2. Cover Handle: Recessed.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, "ELECTRIC." Or as indicated for each service.

I. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

J. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

1. Extension shall provide increased depth of 12 inches (300 mm).
2. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.

K. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

L. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.

1. Splayed location.
2. Knockout panels shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
4. Knockout panels shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
5. Knockout panels shall be 1-1/2 to 2 inches (38 to 50 mm) thick.

M. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct to be terminated.
2. Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.

N. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

## 2.6 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

C. Color: Gray.

D. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

G. Cover Legend: Molded lettering, "ELECTRIC." Or as indicated for each service.

H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

J. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

## 2.7 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER

A. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

C. Color: **[Gray] [Green].**

D. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

G. Cover Legend: Molded lettering, “ELECTRIC.” or as indicated for each service.

H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

J. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

## 2.8 FIBERGLASS HANDHOLES AND BOXES

A. Description: Molded of fiberglass-reinforced polyester resin, with covers made of **[polymer concrete] [reinforced concrete] [cast iron] [hot-dip galvanized-steel diamond plate] [fiberglass].**

B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

C. Color: **[Gray] [Green].**

D. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

G. Cover Legend: Molded lettering, "ELECTRIC." Or as indicated for each service.

H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

J. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

## 2.9 HIGH-DENSITY PLASTIC BOXES

A. Description: Injection molded of HDPE or copolymer-polypropylene. Cover shall be made of polymer concrete.

B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

C. Color: Gray.

D. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

G. Cover Legend: Molded lettering, “ELECTRIC.” or as indicated for each service.

H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

J. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

## 2.10 PRECAST MANHOLES

A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.

B. Comply with ASTM C858.

C. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.

D. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.

1. Splayed location.
2. Knockout panels shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
4. Knockout panel shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
5. Knockout panels shall be 1-1/2 to 2 inches (38 to 50 mm) thick.

E. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct to be terminated.
2. Fittings shall align with elevations of approaching duct and be located near interior corners of manholes to facilitate racking of cable.

F. Ground Rod Sleeve: Provide a 3-inch (75-mm) PVC sleeve in manhole floors 2 inches (50 mm) from the wall adjacent to, but not underneath, the duct entering the structure.

G. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

## 2.11 CAST-IN-PLACE MANHOLES

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for duct entrance and sleeve for ground rod.

B. Materials: Comply with ASTM C858 and with Section 033000 "Cast-in-Place Concrete."

C. Structural Design Loading: As specified in "Underground Enclosure Application" Article.

## 2.12 UTILITY STRUCTURE ACCESSORIES

A. Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A48/A48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 26 inches (660 mm).

a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.

2. Cover Legend: Cast in. Selected to suit system.

a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.

3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.

a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C387, Type M, may be used.
b. Seal joints watertight using preformed plastic or rubber complying with ASTM C990. Install sealing material according to sealant manufacturers' written instructions.

C. Manhole Sump Frame and Grate: ASTM A48/A48M, Class 30B, gray cast iron.

D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.

1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.

E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- (31-mm-) diameter eye, rated 2500-lbf (11-kN) minimum tension.

F. Pulling-in and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.

G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (31 mm) minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.

H. Ground Rod Sleeve: 3-inch (75-mm) PVC sleeve in manhole floors 2 inches (50 mm) from the wall adjacent to, but not underneath, the ducts routed from the facility.

I. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.

J. Cable Rack Assembly: Steel, galvanized, except insulators.

1. Stanchions: T-section or channel with provisions to connect to other sections or channels to form a continuous unit; 1-1/2 inches (38 mm) in width by nominal 24 inches (600 mm) long; punched with 14 hook holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.
2. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 18 inches (450 mm) with 250-lb (114-kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

K. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.

1. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with provisions to connect to other sections to form a continuous unit, with minimum of nine holes for arm attachment.
2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (500 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.

L. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

M. Fixed Manhole Ladders: Arranged for attachment to roof or wall of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.

N. Portable Manhole Ladders: UL-listed, heavy-duty fiberglass specifically designed for portable use for access to electrical manholes. Minimum length equal to distance from deepest manhole floor to grade plus 36 inches (900 mm). One required.

O. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater. Two required.

## 2.13 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.

2. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

### 3.2 UNDERGROUND DUCT APPLICATION

A. Duct for Electrical Cables More Than 600 V: Type EPC-80-PVC RNC, concrete-encased unless otherwise indicated.

B. Duct for Electrical Feeders 600 V and Less: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.

C. Duct for Electrical Branch Circuits: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.

D. Bored Underground Duct: Type EPEC-40-HDPE unless otherwise indicated.

E. Underground Ducts Crossing Driveways or Roadways: Type EPC-40 PVC RNC, encased in reinforced concrete.

F. Stub-ups: Concrete-encased RNC.

### 3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-10 structural load rating.

2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.
5. Cover design load shall not exceed the design load of the handhole or box.

B. Manholes: Precast or cast-in-place concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

## 3.4 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Replace area immediately after backfilling is completed.

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."

E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 017300 "Execution."

## 3.5 DUCT AND DUCT-BANK INSTALLATION

A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.

B. Install duct according to NEMA TCB 2.

C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.

D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1200 mm), both horizontally and vertically, at other locations unless otherwise indicated.

1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.

E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.

F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

G. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell, without reducing duct slope and without forming a trap in the line.
2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch (19 mm).
3. Grout end bells into structure walls from both sides to provide watertight entrances.

H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches (150 mm) o.c. for 4-inch (100-mm) duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to terminator spacing 10 feet (3 m) from the terminator, without reducing duct line slope and without forming a trap in the line.
2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line duct with calculated expansion of more than 3/4 inch (19 mm).

I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet (3 m) outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

J. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

K. Pulling Cord: Install 200-lbf- (1000-N-) test nylon cord in empty ducts.

L. Concrete-Encased Ducts and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
2. Width: Excavate trench 12 inches (300 mm) wider than duct on each side.
3. Width: Excavate trench 3 inches (75 mm) wider than duct on each side.

4. Depth: Install so top of duct envelope is at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
5. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet (6 m) of duct. Place spacers within 24 inches (600 mm) of duct ends. Stagger spacers approximately 6 inches (150 mm) between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
7. Minimum Space between Duct: 3 inches (75 mm) between edge of duct and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and communications ducts.
8. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
9. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.

    a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
    b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inches (100 mm)above finished floor and minimum 3 inches (75 mm)from conduit side to edge of slab.

    c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches (1500 mm) from edge of wall. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inches (100 mm)above finished floor and no less than 3 inches (75 mm)from conduit side to edge of slab.

10. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
11. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
12. Concrete Cover: Install a minimum of 3 inches (75 mm) of concrete cover between edge of duct to exterior envelope wall, 2 inches (50 mm) between duct of like services, and 4 inches (100 mm) between power and communications ducts.
13. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (15-mm) reinforcing-rod dowels extending a minimum of 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.

14. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

M. Direct-Buried Duct and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches (150 mm) in nominal diameter.
2. Width: Excavate trench 12 inches (300 mm) wider than duct on each side.
3. Width: Excavate trench 3 inches (75 mm) wider than duct on each side.
4. Depth: Install top of duct at least 36 inches (900 mm) below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct bank below frost line.
6. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet (6 m) of duct. Place spacers within 24 inches (600 mm) of duct ends. Stagger spacers approximately 6 inches (150 mm) between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
8. Install duct with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and communications duct.
9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.

    a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
    b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inches (100 mm)above finished floor and minimum 3 inches (75 mm)from conduit side to edge of slab.

    c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches (1500 mm) from edge of wall. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inches (100 mm)above finished floor and no less than 3 inches (75 mm)from conduit side to edge of slab.

11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches (100 mm) over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at

end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.

a. Place minimum 3 inches (75 mm) of sand as a bed for duct. Place sand to a minimum of 6 inches (150 mm) above top level of duct.
b. Place minimum 6 inches (150 mm) of engineered fill above concrete encasement of duct.

N. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried duct, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of duct or duct bank. Provide an additional plank for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional planks 12 inches (300 mm) apart, horizontally.

O. Underground-Line Warning Tape: Bury conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches (300 mm) above all concrete-encased duct and duct banks and approximately 12 inches (300 mm) below grade. Align tape parallel to and within 3 inches (75 mm) of centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

## 3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches (38 to 50 mm) thick, arranged as indicated.
3. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches (375 mm) below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
3. Install handholes with bottom below frost line.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of manholes after concrete has cured at least three days. After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

G. Dampproofing: Apply dampproofing to exterior surfaces of manholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

J. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (97 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

## 3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

D. Install handholes and boxes with bottom below frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

## 3.8 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

## 3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch- (300-mm-) long mandrel equal to duct size minus 1/4 inch (6 mm). If obstructions are indicated, remove obstructions and retest.
3. Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

## 3.10 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump.

1. Sweep floor, removing dirt and debris.
2. Remove foreign material.

**END OF SECTION 260543**

# SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

## PART 2 - PRODUCTS

### 2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

## 2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

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

   a. Advance Products & Systems, Inc.
   b. Metraflex Company (The).
   c. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

## 2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

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

   a. Emerson
   b. Innerlynx, Eaton Crouse-Hinds, a Cooper Industries Company
   c. Link-Seal, GPT an EnPro Industries Company
   d. Metraflex

## 2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

## 2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have a VOC content of 50 g/L or less.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

   a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
   b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

### 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

## 3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

**END OF SECTION 260544**

# SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Delegated-Design Submittal: For arc-flash hazard study.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Comply with NFPA 70E and "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

## 2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on a white field.
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
2. Colors for 208/120-V Circuits:

a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.

3. Color for Neutral: White.
4. Color for Equipment Grounds: Bare copper, Green, or Green with a yellow stripe.

C. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

D. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

E. Equipment Identification Labels:

1. Normal Power: Black letters on a White field.

2. Emergency Power: White Letters on a Red field.

## 2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameter and that stay in place by gripping action.

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil thick, vinyl flexible label with acrylic pressure-sensitive adhesive.

1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
2. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3.5-mil thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Minimum Nominal Size:

a. 1-1/2 by 6 inches for raceway and conductors.
b. 3-1/2 by 5 inches for equipment.
c. As required by authorities having jurisdiction.

## 2.4 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameter and that stay in place by gripping action.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameters of and shrunk to fit firmly around item being identified. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

## 2.5 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

C. Tape and Stencil: 4-inch- wide black stripes on 10-inch centers placed diagonally over orange background and is 12 inches wide. Stop stripes at legends.

D. Floor Marking Tape: 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

E. Underground-Line Warning Tape:

1. Tape:

a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications lines.
b. Printing on tape shall be permanent and shall not be damaged by burial operations.
c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

2. Color and Printing:

   a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
   b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE"
   c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".

3. Description:

   a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, compounded for direct-burial service.
   b. Width: 3 inches.
   c. Overall Thickness: 5 mils.
   d. Foil Core Thickness: 0.35 mil.
   e. Weight: 28 lb/1000 sq. ft.
   f. Tensile according to ASTM D882: 70 lbf and 4600 psi.

F. Stenciled Legend: In nonfading, waterproof, black ink, or paint. Minimum letter height shall be 1 inch.

## 2.6 SIGNS

A. Baked-Enamel Signs:
   1. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
   3. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:
   1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
   3. Nominal Size: 10 by 14 inches.

C. Laminated Acrylic or Melamine Plastic Signs:
   1. Engraved legend.
   2. Thickness:

      a. For signs up to 20 sq. in., minimum 1/16 inch thick.
      b. For signs larger than 20 sq. in., 1/8 inch thick.
      c. Engraved legend with black letters on white face
      d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
      e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

## 2.7 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

## 2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Equipment to Be Labeled:

a. Panelboards, electrical cabinets, and enclosures.
b. Electrical switchgear and switchboards.
c. Disconnect switches.
d. Enclosed circuit breakers.
e. Motor starters.
f. Push-button stations.
g. Power transfer equipment.
h. Contactors.
i. Receptacles: Provide panel and circuit designation.

B. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Verify identity of each item before installing identification products.

E. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

F. Apply identification devices to surfaces that require finish after completing finish work.

G. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

H. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

I. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

J. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

K. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

L. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer and/or any emergency operations.

M. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

N. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER"
2. "POWER"
3. "UPS"
4. “LIFE SAFETY”

O. Vinyl Wraparound Labels:

1. Secure tight to surface at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

P. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

Q. Self-Adhesive Wraparound Labels: Secure tight to surface of raceway or cable at a location with high visibility and accessibility.

R. Self-Adhesive Labels:

1. On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.

S. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

T. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

U. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.

V. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

W. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

X. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

Y. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.
2. Install underground-line warning tape for direct-buried cables and cables in raceways.

Z. Write-on Tags:

1. Place in a location with high visibility and accessibility.

AA. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on minimum 1-1/2-inch- (38-mm-) high sign; where two lines of text are required, use signs minimum 2 inches (50 mm) high.

BB. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on minimum 1-1/2-inch- (38-mm-) high sign; where two lines of text are required, use signs minimum 2 inches (50 mm) high.

CC. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on minimum 1-1/2-inch- (38-mm-) high sign; where two lines of text are required, use signs minimum 2 inches (50 mm) high.

DD. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

## 3.2 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER"
2. "POWER"
3. "UPS"
4. “LIFE SAFETY”

E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive wraparound labels to identify the phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use write-on tags self-adhesive wraparound labels with the conductor or cable designation, origin, and destination.

G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with the conductor designation.

H. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

I. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

J. Workspace Indication: Apply floor marking tape and stencil] to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

K. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.

1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

a. Power-transfer switches.
b. Controls with external control power connections.

M. Arc Flash Warning Labeling: Self-adhesive labels.

N. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.

O. Emergency Operating Instruction Signs: Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer and other emergency operations.

P. Equipment Identification Labels:

1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
2. Outdoor Equipment: Laminated acrylic or melamine sign.

**END OF SECTION 260553**

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# SECTION 260573.13 - SHORT-CIRCUIT STUDIES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

### 1.3 ACTION SUBMITTALS

A. Product Data:

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals may be in digital form.

    a. Short-circuit study input data, including completed computer program input data sheets.
    b. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.

        1) Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
        2) Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

### 1.4 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.

B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

G. SCCR: Short-circuit current rating.

H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

I. Single-Line Diagram: See "One-Line Diagram."

## 1.5 QUALITY ASSURANCE

A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

1. Power System Analysis Software Qualifications: Computer program shall be designed to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.
2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

# PART 2 - PRODUCTS

## 2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

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

1. EasyPower.
2. SKM Systems Analysis, Inc.

B. Comply with IEEE 399 and IEEE 551.

1. Analytical features of power systems analysis software program shall have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

## 2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
6. Derating factors and environmental conditions.
7. Any revisions to electrical equipment required by the study.

D. Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.
2. Power sources available.
3. Manufacturer, model, and interrupting rating of protective devices.
4. Conductors.
5. Transformer data.

G. Short-Circuit Study Output Reports:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.

f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

## PART 3 - EXECUTION

### 3.1 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the study.

1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Architect's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
3. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.

B. Gather and tabulate the required input data to support the short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
11. Derating factors.

### 3.2 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin short-circuit current analysis at the service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.
2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.

H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

I. Include in the report identification of any protective device applied outside its capacity.

**END OF SECTION 260573.13**

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# SECTION 260573.16 - COORDINATION STUDIES

## 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 computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1. Study results shall be used to determine coordination of series-rated devices.

### 1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.

B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

E. Power System Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

G. SCCR: Short-circuit current rating.

H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

I. Single-Line Diagram: See "One-Line Diagram."

## 1.4 ACTION SUBMITTALS

A. Product Data:

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

    a. Coordination-study input data, including completed computer program input data sheets.
    b. Study and equipment evaluation reports.

3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.

    a. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

## 1.5 QUALITY ASSURANCE

A. Studies shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

D. Power System Analysis Software Qualifications:

1. Computer program shall be designed to perform coordination studies or have a function, component, or add-on module designed to perform coordination studies.
2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

F. Field Adjusting Agency Qualifications:

1. Employer of a NETA ETT-Certified Technician Level III responsible for all field adjusting of the Work.
2. A member company of NETA.
3. Acceptable to authorities having jurisdiction.

## PART 2 - PRODUCTS

### 2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

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

1. EasyPower.
2. SKM Systems Analysis, Inc.

B. Comply with IEEE 242 and IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:

a. Arcing faults.

### 2.2 COORDINATION STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.
6. Any revisions to electrical equipment required by the study.
7. Study Input Data: As described in "Power System Data" Article.

a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

D. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

a. Phase and Ground Relays:
1) Device tag.
2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
3) Recommendations on improved relaying systems, if applicable.

b. Circuit Breakers:
   1) Adjustable pickups and time delays (long time, short time, and ground).
   2) Adjustable time-current characteristic.
   3) Adjustable instantaneous pickup.
   4) Recommendations on improved trip systems, if applicable.
c. Fuses: Show current rating, voltage, and class.

E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:

   a. Power utility's overcurrent protective device.
   b. Medium-voltage equipment overcurrent relays.
   c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
   d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
   e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
   f. Cables and conductors damage curves.
   g. Ground-fault protective devices.
   h. Motor-starting characteristics and motor damage points.
   i. Generator short-circuit decrement curve and generator damage point.
   j. The largest feeder circuit breaker in each motor-control center and panelboard.

5. Maintain selectivity for tripping currents caused by overloads.
6. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
7. Provide adequate time margins between device characteristics such that selective operation is achieved.
8. Comments and recommendations for system improvements.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

## 3.2 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the overcurrent protective device study.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call any discrepancies to Architect's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
3. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.

B. Gather and tabulate all required input data to support the coordination study. List below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Electrical power utility impedance at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Voltage level at each bus.
6. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
7. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
8. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
9. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
10. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
11. Motor horsepower and NEMA MG 1 code letter designation.
12. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
13. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

## 3.3 COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin analysis at the service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.
2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:
    a. Inrush current when first energized.
    b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
    c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

H. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

J. Generator Protection: Select protection according to manufacturer's written instructions and to IEEE 242.

K. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

L. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.
4. Include in the report identification of any protective device applied outside its capacity.

## 3.4 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:

1. Determine load flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
2. Determine load flow and voltage drop based on 80 percent of the design capacity of load buses.
3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

## 3.5 FIELD ADJUSTING

A. Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of equipment manufacturer under the "Startup and Acceptance Testing" contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

**END OF SECTION 260573.16**

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# SECTION 260573.19 - ARC-FLASH HAZARD ANALYSIS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

### 1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

G. SCCR: Short-circuit current rating.

H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

I. Single-Line Diagram: See "One-Line Diagram."

### 1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form:

1. Arc-flash study input data, including completed computer program input data sheets.
2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
3. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

## 1.5 QUALITY ASSURANCE

A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

# PART 2 - PRODUCTS

## 2.1 COMPUTER SOFTWARE DEVELOPERS

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

1. EasyPower.
2. SKM Systems Analysis, Inc.

B. Comply with IEEE 1584 and NFPA 70E.

C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

## 2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in "Short-Circuit Studies."

F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in "Coordination Studies."

G. Arc-Flash Study Output Reports:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:

    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. No AC Decrement (NACD) ratio.
    e. Equivalent impedance.
    f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
    g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Restricted approach boundary.
6. Limited approach boundary.
7. Working distance.
8. Incident energy.
9. Hazard risk category.
10. Recommendations for arc-flash energy reduction.

I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

## 2.3 ARC-FLASH WARNING LABELS

A. Comply with requirements in "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.

B. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Protection boundaries.

    a. Arc-flash boundary.
    b. Restricted approach boundary.
    c. Limited approach boundary.

4. Arc flash PPE category.
5. Required minimum arc rating of PPE in Cal/cm squared.
6. Available incident energy.
7. Working distance.
8. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

### 3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Calculate maximum and minimum contributions of fault-current size.

1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
2. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
3. Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.
4. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.

C. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

D. Include medium- and low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.

E. Calculate the limited, restricted, and prohibited approach boundaries for each location.

F. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

G. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

H. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

## 3.3 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the arc-flash hazard analysis.

1. Verify completeness of data supplied on one-line diagram on Drawings. Call discrepancies to Architect's attention.
2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance or available short circuit current at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Voltage level at each bus.
6. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
7. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
8. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
9. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
10. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
11. Motor horsepower and NEMA MG 1 code letter designation.
12. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
13. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

## 3.4 LABELING

A. Apply one arc-flash label on the front cover of each section of the equipment for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.

B. Each piece of equipment listed below shall have an arc-flash label applied to it:

1. Motor-control center.
2. Low-voltage switchboard.
3. Switchgear.
4. Medium-voltage switch.
5. Medium voltage transformers
6. Low voltage transformers. Exclude transformers with high voltage side 240 V or less and less than 125 kVA.
7. Panelboard and safety switch over 250 V.
8. Applicable panelboard and safety switch under 250 V.

C. Note on record Drawings the location of equipment where the personnel could be exposed to arc-flash hazard during their work.

1. Indicate arc-flash energy.
2. Indicate protection level required.

## 3.5 APPLICATION OF WARNING LABELS

A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

**END OF SECTION 260573.19**

## SECTION 26 08 00 – COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Documents:

1. Drawings and general provisions of the Subcontract apply to this Section.

2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Section Includes:

1. This section specifies the unique responsibilities that are a part of, or are related to the commissioning process for the electrical systems. Electrical systems include those listed in Division 01 Section "General Commissioning Requirements" as being commissioned. All statements are the responsibility of the Subcontractor, unless specifically stated otherwise.

2. Electrical testing specified for systems not listed as formally commissioned are not under the commissioning umbrella and are not governed by this section.

3. Electrical Systems Commissioning consists of static checks of component and system installations and actual testing of equipment conditions and functions.

4. The Commissioning Authority will review and approve, prior to use, all test procedures and forms used and will witness a varying fraction of the initial checks and testing performed by the Subcontractor. The Commissioning Authority will review the completed check and test documentation of the Subcontractor of all checks and tests.

5. Electrical testing requirements are found in various sections in Division 01 and in Division 26 (Division 01 Section "General Commissioning Requirements" and this section). It is not the intent of the commissioning process or these specifications to duplicate efforts or to require the Subcontractor to perform any check or test twice. Checks and testing by the Subcontractor are expected to occur once in the normal sequence of installation and checkout if appropriate coordination has occurred allowing the Commissioning Authority to witness installations and initial testing. Identical electrical checks and testing requirements in both Division 01 and Division 26 are referring to the same event.

6. The test requirements listed in this section do not release the Subcontractor from the obligation to perform all other appropriate, industry standard, manufacturer-recommended or code-required checks and tests.

7. Testing Participants. The work of this section shall be performed by parties identified in the Check and Testing Responsibility Table--a supplement to Division 01 Section "General Commissioning Requirements". Static checks and testing shall be fully documented according to provisions in Division 01 Section "General Commissioning Requirements".

C. Related Sections:

1. Division 01 Section "General Requirements."

2. Division 01 Section "Special Procedures."

3. Division 01 Section "General Commissioning Requirements".

1.2 SUBMITTALS

A. Submit under provisions of Divisions 01 Section "General Requirements" and "Special Procedures."

1.3 QUALITY ASSURANCE

A. Qualifications:

1. The CTC (Certified Testing Company) performing the work of this section shall be qualified to test electrical equipment and is a NETA (National Electrical Testing Association)-certified testing agency. The CTC shall not be associated with the manufacturer of equipment or systems under test.

B. Test Equipment:

1. The Subcontractor shall provide all test equipment necessary to fulfill the checks and testing requirements. Test equipment shall have been calibrated within one (1) year of its use on the project.

2. Refer to Division 01 Section "General Commissioning Requirements" for additional requirements.

PART 2 - EXECUTION

2.1 SUBMITTALS

A. Sixty (60) days before any testing is conducted, submit an overall testing plan and schedule for electrical systems that lists the equipment, modes to be tested, dates of testing and parties conducting the tests. Put these tests into the master construction schedule. Keep this plan and schedule updated.

B. Additional submittal requirements relative to commissioning are found in this Section and in Division 01 Section "General Commissioning Requirements" and Division 01 Section "General Requirements."

2.2 COMMON RESPONSIBILITIES

A. The following are responsibilities applicable to all electrical systems being commissioned.

B. The general commissioning requirements and coordination are detailed in Division 01 Section "General Commissioning Requirements" and apply to electrical systems. The Subcontractor shall be familiar with all parts of Division 01 Section "General Commissioning Requirements" and the commissioning plan issued by the Commissioning Authority and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

C. The work of this Section shall be performed by a CTC (Certified Testing Company, Electrical), by the EC (Electrical Subcontractor), or the MSR (Manufacturer's Service Representative). The Commissioning Authority has some testing responsibilities for some equipment. The specified

checks and static tests are conducted by any of the above listed parties, but the tests requiring measurements or special tools, or skills are generally conducted only by the CTC. The Check and Testing Responsibility Table, included as a supplement to Division 01 Section "General Commissioning Requirements" provides specific allocation of checklist oversight and testing responsibilities. The CTC, EC, and MSR shall document all checks and testing on check and test procedure forms submitted to and approved by the Commissioning Authority prior to testing.

D. The Subcontractor shall notify the CA ahead of time when commissioning activities not yet performed or not yet scheduled will delay construction. The Subcontractor shall be proactive in seeing that commissioning processes are executed, and that the CA has the scheduling information needed to efficiently execute the commissioning process.

E. The Subcontractor shall respond to notices of issues identified during the commissioning process, making required corrections or clarifications, and returning prompt notification to the Commissioning Authority according to the process given in Division 01 Section "General Commissioning Requirements".

F. When completion of a task or other issue has been identified as holding up any commissioning process, particularly functional testing, the Subcontractor shall, within two (2) days of notification of the issue, notify the Commissioning Authority in writing providing an expected date of completion. The Subcontractor shall notify the Commissioning Authority in writing within one day of completion. It is not the responsibility of the Commissioning Authority to obtain this status information through meeting attendance, asking questions or field observation

G. Construction Checklists. The Commissioning Authority or Subcontractor shall develop checklists as noted in the list of commissioned systems in Division 01 Section "General Commissioning Requirements", following the process described in Division 01 Section "General Commissioning Requirements" and in this Section. At a minimum, for a given piece of equipment, checks from the inspection checklists in NETA Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems shall be included in the electrical checklists. The Subcontractor shall execute and document all checks.

H. Check and testing procedure and startup plan development and execution responsibilities are described in the Check and Testing Responsibility Table in the supplements to Division 01 Section "General Commissioning Requirements".

I. The Subcontractor shall review design documents, shop drawings and O&M manuals and manufacturer recommended installation and testing procedures of each system installation.

J. The Subcontractor shall monitor installation to ensure the equipment, configuration and quality of construction meets the design requirements, approved submittals, and shop drawings.

K. The Subcontractor shall develop test procedures and forms and execute and document testing according to the requirements of this Section, Division 01 Section "General Commissioning Requirements" and other specification sections containing testing requirements.

L. Tests of energized equipment shall be conducted when the equipment is operating at its normal capacity. This may require some tests to be conducted after occupancy.

M. Training and Orientation. The Subcontractor shall follow the facility staff orientation and training requirements as described in Division 01 Section "Demonstration and Training" and other applicable technical sections.

N. Operation And Maintenance (O&M) Manuals. Refer to Division 01 Section "General Commissioning Requirements" and Division 01 Section "General Requirements" for requirements for O&M manuals.

## PART 3 - EQUIPMENT-SPECIFIC VERIFICATION AND TESTING REQUIREMENTS

### 3.1 SUMMARY

A. This Part specifies the check and testing requirements for electrical components and systems. From these requirements, the Commissioning Authority or Subcontractor will develop detailed procedures and forms. The general testing process, requirements and test method definitions are described in Division 01 Section "General Commissioning Requirements".

### 3.2 CHECKS AND TESTS

A. Checks are intended to begin upon completion of a component or equipment installation. Testing generally occurs later when systems are energized or nearing that point. Beginning system testing before full completion, does not relieve the Subcontractor from fully completing the system as soon as possible, including all construction checklists and may require retesting portions of the system once all components are fully functioning.

B. Refer to Division 01 Section "General Commissioning Requirements" for specific details on non-conformance issues relating to construction checklists and tests. Refer to Division 01 Section "General Commissioning Requirements", for common requirements of deferred testing and to articles in this Section.

C. The check and test procedures and record forms shall contain the following:

1. The Subcontractors executing the checks or tests.

2. A list of the integral components being inspected and tested, equipment tag numbers, manufacturer, model number, pertinent performance information / rating data.

3. Test equipment used.

4. Construction checklists associated with the components, if any.

5. Any special required conditions of the check or test for each procedure.

6. Items, conditions or functions to be inspected, verified or tested, the checks and testing method given, and a place provided with results recorded.

7. Acceptance criteria (or reference by specific table where the acceptance criteria is found).

8. For each procedure, list the technician performing check or test and company, witnesses of the tests and dates of tests.

9. Sampling strategies used.

D. The test procedures for dynamic equipment like lighting controls, emergency generator or fire alarm shall contain more step-by-step procedures with expected responses similar to the sample test provided as a supplement to Division 01 Section "General Commissioning Requirements". The test procedures and forms for more static components like panel boards, switch gear, circuit breakers, transformers, etc., can be more checklist-like in format. For each piece of equipment, checks and test procedures and their documentation record forms may be different documents or combined in the same document, but checks and tests should be grouped.

E. At the Commissioning Authority's discretion, if large numbers or repeated deficiencies are encountered, the Subcontractor shall test and troubleshoot all remaining systems at issue on their own before commissioning with the Commissioning Authority will resume.

F. Sampling for Identical Units. When there are a number of identical units, at the Commissioning Authority's discretion, some, or all procedures of a test for a piece of equipment or assembly may be omitted when these same tests on other pieces of identical equipment or assemblies were conducted without deficiency.

## 3.3 EQUIPMENT-SPECIFIC TESTING REQUIREMENTS

A. The following paragraphs define the testing requirements for each type of system or feature that is a part of the project. The Commissioning Authority shall use this information to develop specific testing procedures for each of the systems to be commissioned. The Subcontractor shall be responsible for support, execution and coordination of these tests as described in the project specifications including intersystem tests and interlocks with systems in Divisions other than Division 26.

B. Common Testing Requirements

1. The following requirements apply to all electrical systems and features that are to be commissioned when referenced below. Tests shall:

a. Verify functionality and compliance with the design intent for each individual sequence module in the sequences of operation. Verify proper operation of all control strategies, energy efficiency and self-diagnostics features by stepping through each sequence and documenting equipment and system performance. Test every step in every written sequence and other significant modes, sequences and operational features not mentioned in written sequences; including startup, normal operation, shutdown, scheduled on and off, unoccupied, and manual modes, safeties, alarms, over-rides, lockouts and power failure.

b. Verify all alarm and high and low limit functions and messages generated on all points with alarm settings.

c. Verify integrated performance of all components and control system components, including all interlocks and interactions with other equipment and systems.

d. Verify shut down and restart capabilities both for scheduled and unscheduled events (e.g., power failure recovery and normal scheduled start/stop).

e. When applicable, demonstrate a full cycle from off to on and no load to full load and then to no load and off.

f. Verify time of day schedules and setpoints.

g. Verify all energy saving control strategies.

h. Verify that monitoring system graphics are representative of the systems and that all points and control elements are in the same location on the graphic as they are in the field.

i. Verify operator control of all command able control system points including proper security level access.

j. When testing procedures for commissioned equipment are listed in NETA Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems the NETA test procedures shall be part of the testing requirements of this specification. Additional testing procedures may be listed in this specification.

k. Common Acceptance Criteria

2. The following common acceptance criteria apply to all mechanical equipment, assemblies, and features:

a. For the conditions, sequences and modes tested, the equipment, integral components and related equipment shall respond to varying loads and changing conditions and parameters appropriately as expected, according to the sequences of operation, as specified, according to acceptable operating practice and the manufacturer's performance specifications. Verify that equipment operates within tolerances specified in governing codes, acceptance criteria contained in the construction documents, manufacturer's literature and according to good operating practice.

b. Systems shall accomplish their intended function and performance.

c. All safety trips shall require a manual reset to allow a system restart.

d. Resetting a manual safety shall result in a stable, safe, and predictable return to normal operation by the system.

e. Safety circuits and permissive control circuits shall function in all possible combinations of selector switch positions (hand, auto, inverter, bypass, etc.).

f. Other acceptance criteria is given in the equipment testing requirements articles or referenced standards.

g. Additional acceptance criteria will be developed by the Commissioning Authority when detailed test procedures are developed.

h. When testing procedures for commissioned equipment are listed in NETA Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems the NETA performance criteria shall apply.

C. Equipment-Specific Testing Requirements:

1. Scheduled Lighting Controls.

a. Apply the applicable common testing requirements and acceptance criteria.

b. Test Methods. Utilize active testing, and trending when available. If able to trend, trend all zones over a week period and follow the trending guidelines in Division 23 Section "Commissioning of HVAC".

c. Sampling Strategy. Manually test 20 percent of the zones or at least four. If more than 10 percent or two zones fail, test another 10 percent sample. If the second sample fails the Subcontractor shall document retesting on all zones on their own using a Commissioning Authority approved form.

2. Occupancy/Vacancy Sensor Lighting Controls.

a. Apply applicable common testing requirements and acceptance criteria. Test all units' functions, including sensor sensitivity and time-to-OFF functions and ensure that sensor location is proper and won't be tripped inadvertently by other occupants and movements outdoors, etc.

D. Test Methods. Utilize active test methods.

1. Sampling Strategy. Test 10 percent of the sensors or six, whichever is greater. If more than 10 percent or two sensors fail, test another 10 percent sample. If the second sample fails, the Subcontractor shall document retesting on all units on their own using a Commissioning Authority approved form.

2. Additional Acceptance Criteria. Reasonable sensitivity, no inadvertent trips, lights go off within 15 seconds of design.

3. Emergency Generator System

a. Apply applicable common testing requirements and acceptance criteria.

b. Test according to NETA 7.22.1 and NFPA 110 5.13 and per Division 01 Section "Special Procedures."

c. Record all data and results.

d. Include the following tests:

1) When in enclosed spaces, verify combustion and ventilation air damper functions and pressure drop of exhaust.

2) Verify fuel oil system, diesel fuel storage tank, and level and low fuel indication alarms.

3) Verify all alarms, meters, and auxiliaries and interlocks to the BAS.

e. Building Test. Under a cold generator condition, provide full utility power interruption under load and cause emergency power service operation. If applicable, include all UPS in this test. Load bank the UPS if necessary, during test.

f. Verify all generator functions

g. Test auto-transfer switch operation under actual voltage drop, per specification Division 26 Section "Transfer Switches".

h. Using a power line disturbance monitor, measure the following times: power failure to engine start command, engine start command to engine start (cranking time), engine start to point where generator is at proper volts and frequency and total time from power failure until ATS switches.

i. Verify system reporting & control monitoring point-to-point

j. Verify that each circuit and equipment served by emergency power, does power up. Verify all functions of the Emergency Power Response Matrix.

k. Verify appropriate mechanical system and control system restart functions of all equipment served by the generator.

4. Step Load Tests.

   a. Test at 0 percent, 25 percent, 50 percent, and 100 percent of full load. Measure voltage and frequency and record all gaged engine conditions. The test shall consist of running the engine-generator while connected to the resistive load bank for one hour, and then shutting down for 30 minutes.

   b. Test for multiple generator starts.

   c. Verify all operational data and start-up minimum time interval.

   d. Verify 2-hour full load run full load bank (building load can serve as part of the load).

   e. Verify all generator-running characteristics.

   f. Verify battery-charging system.

5. Fire Alarm.

   a. Apply applicable common testing requirements and acceptance criteria.

   b. Test the fire alarm system according to NFPA 110-1999 7-1 through 7-2, and specification Division 28 Section "Multiplex Addressable Fire Alarm System – Voice Evacuation".

   c. Document all test procedures and results. A fire alarms system printout of the test annunciation record is not sufficient documentation.

   d. Verify all fire alarm panel functions, alarms, and troubles.

   e. Verify all functions in the Fire Alarm Response Matrix, including remote communications.

   f. Verify resetting of all equipment affected by an alarm.

   g. Sampling Strategy. Verify device functions and annunciations per using the approved sampling rate of the authority having jurisdiction and per LBNL.

**END OF SECTION 26 08 00**

# SECTION 260923 - LIGHTING CONTROL DEVICES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Indoor occupancy and vacancy sensors.
2. Switchbox-mounted occupancy sensors.
3. High-bay occupancy sensors.
4. Emergency shunt relays.
5. Conductors and Cables

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, and manual light switches.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:

a. Occupancy sensors.
b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

### 1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranties.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

B. Hardware and Firmware Operational Documentation:

1. Hardware operating and upgrade manuals.

## 1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of lighting control software.
b. Faulty operation of lighting control devices.

2. Warranty Period: Two year(s) from date of Substantial Completion and consisting of a one for one device replacement.

# PART 2 - PRODUCTS

## 2.1 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Requirements for Sensors:

1. Wall or Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
2. Passive infrared or Dual technology (as indicated on drawings).
3. Hardwired connection to switch.
4. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Operation:

a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 20 minutes.
b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 20 minutes.

6. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
7. Power: Integral photovoltaic collector.
8. Mounting:

a. Sensor: Suitable for mounting in any position on a standard outlet box.
b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

9. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
10. Bypass Switch: Override the "on" function in case of sensor failure.

B. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.

2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

## 2.2 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox using hardwired connection.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 20 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
4. Switch Rating: Not less than 1000-VA LED load at 120 V, 1200-VA LED load at 277 V.

B. Wall-Switch Sensor:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 2100 sq. ft (196 sq. m).
2. Sensing Technology: Dual technology.
3. Switch Type: SP, manual "on," automatic "off."
4. Capable of controlling load in three-way application.
5. Voltage: Dual voltage - 120 and 277 V.
6. Concealed, field-adjustable, "off" time-delay selector at up to 20 minutes.
7. Color: Coordinate color of switch and faceplate requirements with Section 262726 “Wiring Devices”.

## 2.3 HIGH-BAY OCCUPANCY SENSORS

A. Description: Solid-state unit. The unit is designed to operate with the fixtures and driver indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
3. Operating Ambient Conditions: 32 to 149 deg F (0 to 65 deg C).
4. Mounting: Suitable for mounting in any position on a standard outlet box.
5. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind cover.
6. Detector Technology: PIR.

B. Detector Coverage: PIR lenses, suitable for mounting heights from 12 to 50 feet (3.7 to 15.2 m).

## 2.4 EMERGENCY SHUNT RELAY

A. Description: NC, electrically held relay, arranged for wiring in parallel with automatic switching contacts; complying with UL 924.

1. Coil Rating: 120 or 277 V.

## 2.5 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 SENSOR INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

## 3.3 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm) when installed in inaccessible spaces. Utilizing adjacent line voltage power conduit is acceptable providing that insulation requirements are maintained (600V). Exposed conductors in accessible spaces is acceptable when proper cabling installation techniques are utilized.

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

F. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
3. Load Parameters (e.g. blink warning, etc.)

## 3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

1. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

## 3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Tests and Inspections: Manufacturer's service representative shall perform the following inspections and prepare reports.

1. Verify Class I and II wiring connections are terminated properly by validating system performance.
2. Set IP addresses and other network settings of system front end hardware per facilities IT instructions.
3. Verify / complete task programming for all switches, dimmers, time clocks, and sensors.
4. Verify that the control of each space complies with the Sequence of Operation.
5. Correct any system issues and retest.

C. Lighting control devices will be considered defective if they do not pass tests and inspections.

D. Provide a report in table format with drawings or using a software file that can be opened in the manufacturer's system software including each room or space that has lighting control installed. Indicate the following:

1. Date of test or inspection.
2. Loads per space, or Fixture Address identification.
3. Quantity and Type of each device installed
4. Reports providing each device's settings.

## 3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

## 3.7 FIRMWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include firmware support for two years.

B. Upgrade Service: At Substantial Completion, update firmware to latest version. Install and program firmware upgrades that become available within two years from date of Substantial Completion.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade equipment if necessary.

## 3.8 DEMONSTRATION

A. Before Substantial Completion, arrange and provide a one-day Owner instruction period to designated Owner personnel. Set-up, starting of the lighting control system and Owner instruction includes:

1. Confirmation of entire system operation and communication to each device.
2. Confirmation of operation of individual relays, switches, and sensors.
3. Confirmation of system Programming, override settings, etc.
4. Provide training to cover installation, programming, operation, and troubleshooting of the lighting control system.

## 3.9 PRODUCT SUPPORT AND SERVICE

A. Factory telephone support shall be available at no cost to the Owner following acceptance. Factory assistance shall consist of assistance in solving application issues pertaining to the control equipment.

END OF SECTION 260923

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# SECTION 260943 - DISTRIBUTED INTELLIGENCE BASED LIGHTING CONTROL

## PART 1 GENERAL

### 1.1 SECTION INCLUDES

A. Distributed Digital Lighting Control System: System includes
   1. Digital Lighting Controls
   2. Emergency Lighting Control.

### 1.2 RELATED SECTIONS

A. Section 26 51 19 – LED Interior Lighting.

B. Section 26 56 19 – LED Exterior Lighting.

C. Section 26 52 13 - Emergency and Exit Lighting.

### 1.3 REFERENCES

A. NFPA 70 - National Electrical Code; National Fire Protection Association.

B. NEMA - National Electrical Manufacturers Association

C. FCC emission standards

D. UL - Underwriters Laboratories, Inc. Listings

E. UL 20 - General Use Switches, Plug Load Controls

F. UL 924 - Standard for Emergency Lighting and Power Equipment

### 1.4 DESIGN / PERFORMANCE REQUIREMENTS

A. Digital Lighting Management System shall accommodate the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories that suit the required lighting and electrical system parameters.

B. System shall conform to requirements of NFPA 70.

C. System shall comply with FCC emission standards specified in part 15, sub-part J for commercial and residential application.

D. System shall be listed under UL sections 916 and/or 508.

### 1.5 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Catalog sheets and specifications.
   2. Ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
   3. Storage and handling requirements and recommendations.
   4. Installation instructions.

C. Shop Drawings: Wiring diagrams for the various components of the System specified including:
   1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed.
   2. Show location of all devices, including at minimum sensors, load controllers, and switches/dimmers for each area on reflected ceiling plans.
   3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
   4. Network riser diagram including floor and building level details. Include network cable specification. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.

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

E. Closeout Submittals:
   1. Project Record Documents: Record actual installed locations and settings for lighting control devices.
   2. Operation and Maintenance Manual:
      a. Include approved Shop Drawings and Product Data.
      b. Include Sequence of Operation, identifying operation for each room or space.
      c. Include manufacturer's maintenance information.
      d. Operation and Maintenance Data: Include detailed information on device programming and setup.
      e. Include startup and test reports.

## 1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing of centralized and distributed lighting control systems with a minimum of 10 years documented experience.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation

## 1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

B. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
   1. Ambient temperature: 32 to 104 degrees F (0 to 40 degrees C).
   2. Relative humidity: Maximum 90 percent, non-condensing.

## 1.9 WARRANTY

A. Manufacturer shall provide a 5 year limited warranty on products within this installation, except where otherwise noted, and consisting of a one for one device replacement.

# PART 2 PRODUCTS

## 2.1 MANUFACTURERS

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

1) WattStopper, a division of Legrand North America, LLC.
2) nLIGHT, a division of Acuity Brands Inc.
3) NX Lighting Controls, HLI Solutions, Inc.

B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

## 2.2 DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEM

A. System General: Provide Digital Lighting Management System complete with all necessary enclosures, wiring, and system components to ensure a complete and properly functioning system as indicated on the Drawings and specified herein. If a conflict is identified, between the Drawing and this Specification, contact the Architect for clarification prior to proceeding.
   1. Space Control Requirements: Provide occupancy/vacancy sensors with Manual- or Partial-ON functionality as indicated in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and Automatic-ON occupancy sensors are more appropriate. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room. For spaces with multiple occupants, or where line-of-sight may be obscured, provide ceiling- or corner-mounted sensors and Manual-ON switches.
   2. Daylit Areas: Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) where daylight contribution is available as defined by relevant local building energy code:
      a. All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylit zones.
      b. Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes.
      c. Multiple-level switched daylight harvesting controls may be utilized for areas marked on drawings.
      d. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.
   3. Conference, meeting, training, auditoriums, and multipurpose rooms shall have controls that allow for independent control of each local control zone. Occupancy / vacancy sensors shall be provided to turn off all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.

B. Equipment Required: Lighting Control and Automation system as defined under this section covers the following equipment.
   1. Digital Lighting Management local network: Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
   2. Digital Room Controllers: Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring capabilities.
   3. Digital Occupancy Sensors: Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
   4. Digital Switches: Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches.
   5. Digital Daylighting Sensors: Single-zone closed loop, multi-zone open loop and single-

zone dual-loop daylighting sensors with two-way active infrared (IR) communications for daylight harvesting using switching, bi-level, tri-level or dimming control.

6. Digital Lighting Management segment network: Linear topology, BACnet MS/TP network (1.5 twisted pair, shielded) to connect multiple local networks for centralized control.
7. Network Bridge: Provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS) and automatically creates BACnet objects representative of connected devices.
8. Segment Manager: BACnet MS/TP-based controller with web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.

## 2.3 DIGITAL LOAD CONTROLLERS

A. Digital Load Controllers: Digital controllers for lighting zones, fixtures automatically bind room loads to the connected control devices in the space without commissioning or the use of any tools. Provide controllers to match the room lighting requirements. Controllers are simple to install, and do not have dip switches/potentiometers, or require special configuration for standard Plug n' Go applications. Control units include the following features

1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
2. Simple replacement using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf device.
3. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are assigned based on each controller's device ID's from highest to lowest.
4. Device Status LEDs to indicate:
   a. Data transmission
   b. Device has power
   c. Status for each load
   d. Configuration status
5. Quick installation features including:
   a. Standard junction box mounting
   b. Quick low voltage connections using standard RJ-45 patch cable
6. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
   a. Turn on to 100 percent
   b. Turn off
   c. Turn on to last level
7. Each load be configurable to operate in the following sequences based on occupancy:
   a. Auto-on/Auto-off (Follow on and off)
   b. Manual-on/Auto-off (Follow off only)
8. BACnet object information shall be available for the following objects:
   a. Load status
   b. Schedule state, normal or after-hours
   c. Demand Response enable and disable
   d. Room occupancy status
   e. Total room lighting and plug loads watts
9. UL 2043 plenum rated
10. Manual override and LED indication for each load
11. Zero cross circuitry for each load
12. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.

13. Dimming Room Controllers shall share the following features:
    a. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
    b. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
    c. Override button for each load provides the following functions:
        1) Press and release for on/off control
        2) Press and hold for dimming control
    d. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
    e. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100 percent dimming range defined by the minimum and maximum calibration trim.
    f. Calibration and trim levels must be set per output channel. Devices that set calibration or trim levels per controller (as opposed to per load) are not acceptable.
    g. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.

B. On/Off Room Controllers shall include:
    1. Dual voltage (120/277 VAC, 60 Hz) capable rated for 20A total load
    2. One or two relay configuration
    3. Simple 150 mA switching power supply.
    4. Three RJ-45 local network ports with integral strain relief and dust cover

C. On/Off/0-10V Dimming KO Mount Room Controllers shall include:
    1. Dual voltage (120/277 VAC, 60 Hz) capable rated for 10A (or greater) total load
    2. One or two relays configurations
    3. Smart 150 mA switching power supply
    4. Two RJ-45 local network ports. Provide molded strain relief ring
    5. One dimming output per relay
        a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting.

D. On/Off/ Forward Phase Dimming Room Controllers shall include:
    1. Dual voltage (120/277 VAC, 60 Hz) rated for 20A total load, with forward phase dimmed loads derating to 16A for some load types
    2. One or two relays configurations
    3. Smart 250 mA switching power supply
    4. Four RJ-45 local network ports. Provide integral strain relief
    5. One dimming output per relay
        a. Line Voltage, Forward Phase Dimming - Where indicated, one forward phase control line voltage dimming output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads.

## 2.4 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR

A. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and

electronic documentation. Features include the following:

1. Digital calibration and pushbutton configuration for the following variables:
   a. Sensitivity, 0-100 percent in 10 percent increments
   b. Time delay, 1-30 minutes in 1 minute increments
   c. Test mode, Five second time delay
   d. Detection technology, PIR, Ultrasonic or Dual Technology activation and/or re-activation.
   e. Walk-through mode
2. Load parameters options including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included on the local network.
3. Programmable control functionality including:
   a. Each sensor may be programmed to control specific loads within a local network.
   b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
   c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
   d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
   e. Ultrasonic and Passive Infrared
   f. Ultrasonic or Passive Infrared
   g. Ultrasonic only
   h. Passive Infrared only
   i. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
4. One or two RJ-45 port(s) for connection to local network.
5. Device Status LEDs, which may be disabled for selected applications, including:
   a. PIR detection
   b. Ultrasonic detection
   c. Configuration mode
   d. Load binding
6. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
7. Manual override of controlled loads.
8. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.

B. BACnet object information shall be available for the following objects:
   1. Detection state
   2. Occupancy sensor time delay
   3. Occupancy sensor sensitivity, PIR and Ultrasonic

C. Units shall not have any dip switches or potentiometers for field settings

## 2.5 DIGITAL WALL SWITCH OCCUPANCY SENSORS

A. Digital Occupancy Sensors shall provide scrolling LCD display for digital calibration and electronic documentation. Features include the following:
   1. Digital calibration and pushbutton configuration for the following variables:
      a. Sensitivity: 0-100 percent in 10 percent increments
      b. Time delay: 1-30 minutes in 1 minute increments
      c. Test mode: Five second time delay
      d. Detection technology: PIR, Dual Technology activation and/or re-activation.

e. Walk-through mode
f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the local network.

2. Programmable control functionality including:
   a. Each sensor may be programmed to control specific loads within a local network.
   b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
   c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically during the configurable period of time (default 10 seconds) after turning off.
   d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
      1) Ultrasonic and Passive Infrared
      2) Ultrasonic or Passive Infrared
      3) Ultrasonic only
      4) Passive Infrared only
3. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
4. Two RJ-45 ports for connection to local network.
5. Device Status LEDs including
   a. PIR detection
   b. Ultrasonic detection
   c. Configuration mode
   d. Load binding
6. Assignment of any occupancy sensor to a specific load within the room without wiring or special tools.
7. Assignment of local buttons to specific loads within the room without wiring or special tools
8. Manual override of controlled loads
9. All digital parameter data programmed into an individual wall switch sensor shall be retained in non-volatile FLASH memory within the wall switch sensor itself. Memory shall have an expected life of no less than 10 years.

B. BACnet object information shall be available for the following objects:
   1. Detection state
   2. Occupancy sensor time delay
   3. Occupancy sensor sensitivity, PIR and Ultrasonic
   4. Button state
   5. Switch lock control
   6. Switch lock status

C. Units shall not have any dip switches or potentiometers for field settings.

D. Two-button wall switch occupancy sensors, when connected to a single relay dimming room or fixture controller, shall operate in the following sequence as a factory default:
   1. Left button
      a. Press and release - Turn load on
      b. Press and hold - Raise dimming load
   2. Right button
      a. Press and release - Turn load off
      b. Press and hold - Lower dimming load

E. Low voltage momentary pushbuttons shall include the following features:
   1. Load/Scene Status LED on each switch button with the following characteristics:

a. Bi-level LED
b. Dim locator level indicates power to switch
c. Bright status level indicates that load or scene is active

## 2.6 DIGITAL WALL SWITCHES

A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:
   1. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
   2. Load/Scene Status LED on each switch button with the following characteristics:
      a. Bi-level LED
      b. Dim locator level indicates power to switch
      c. Bright status level indicates that load or scene is active
      d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
   3. Programmable control functionality including:
      a. Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority
      b. Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.
   4. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.

B. BACnet object information shall be available for the following objects:
   1. Button state
   2. Switch lock control
   3. Switch lock status

C. Two RJ-45 ports for connection to the local network.

D. Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.
   1. Individual button function may be configured to Toggle, On only or Off only.
   2. Individual scenes may be locked to prevent unauthorized change.
   3. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
   4. Ramp rate may be adjusted for each dimmer switch.
   5. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.

## 2.7 DIGITAL DAYLIGHTING SENSORS

A. Digital daylighting sensors shall work with load controllers and relay panels to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.
   1. Closed loop sensors measure the ambient light in the space and control a single lighting zone.
   2. Open loop sensors measure incoming daylight in the space and are capable of controlling up to three lighting zones.

B. Digital daylighting sensors shall include the following features:
   1. Sensor's internal photodiode shall only measure lightwaves within the visible

spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. Photodiode shall not measure energy in either the ultraviolet or infrared spectrums. Photocell shall have a sensitivity of less than 5 percent for any wavelengths less than 400 nanometers or greater than 700 nanometers.

2. Sensor light level range shall be from 1-6,000 foot-candles (fc) minimum.
3. Capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
4. For switching daylight harvesting, the photosensor shall provide a field-selectable deadband, or a separation, between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling excessively after they turn off.
5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
6. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
7. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
8. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
9. Configuration LED status light on device that blinks to indicate data transmission.
10. Status LED indicates test mode, override mode and load binding.
11. Recessed switch on device to turn controlled load(s) ON and OFF.
12. BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:
    a. Light level
    b. Day and night setpoints
    c. Off time delay
    d. On and off setpoints
    e. Up to three zone setpoints
    f. Operating mode - on/off, bi-level, tri-level or dimming
13. One RJ-45 port for connection to the local network.
14. A choice of accessories to accommodate multiple mounting methods and building materials. Photosensors may be mounted on a ceiling tile, skylight light well or backbox.
15. Any load or group of loads in the room can be assigned to a daylighting zone
16. Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).
17. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.

C. Closed loop digital photosensors shall include the following additional features:
1. An internal photodiode that measures light in a 100-degree angle, cutting off the unwanted light from bright sources outside of this cone.
2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.
3. Automatically establishes application-specific setpoints following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of loads.

D. Open loop digital photosensors shall include the following additional features:
1. An internal photodiode that measures light in a 60-degree angle (cutting off the

unwanted light from the interior of the room).

2. Automatically establishes application-specific setpoints following manual calibration using a wireless configuration tool or a PC with appropriate software. For switching operation, an adequate deadband between the ON and OFF setpoints for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.
3. Each of the three discrete daylight zones can include any non overlapping group of loads in the room.

## 2.8 HANDHELD CONFIGURATION TOOLS

A. Provide a wireless configuration tool to facilitate customization of the local network using two-way infrared communications, and/or PC software that connects to each local network via a USB interface.

B. Features and functionality of the wireless configuration tool shall include but not be limited to:
1. Two-way infrared (IR) communication with IR-enabled devices within a range of approximately 30 feet.
2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
3. Must be able to read and modify parameters for load controllers and relay panels, occupancy sensors, wall switches, daylighting sensors, network bridges, and identify network devices by type and serial number.
4. Save up to eight occupancy sensor setting profiles, and apply profiles to selected sensors.
5. Temporarily adjust light level of any load(s) on the local network and incorporate those levels in scene setting. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
6. Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.
7. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
8. Verify status of building level network devices.

## 2.9 SEGMENT NETWORK

A. Provide a segment network using linear topology, BACnet-based MS/TP (or Cat-5e) subnet to connect local networks (rooms).
1. Network bridges, relay panels and segment managers shall include terminal blocks, with provisions for separate "in" and "out" terminations, for segment network connections.
2. Segment network utilizes 1.5 twisted pair, shielded, cable supplied by the lighting control manufacturer. Maximum cable run for each segment is 4,000 feet. Conductor-to-conductor capacitance of the twisted pair shall be less than 30 pf/ft and have a characteristic impedance of 120 Ohms.
3. Network wire jacket is available in high visibility green, white, or black.
4. Substitution of manufacturer-supplied cable is not permitted and may void the warranty, if non-approved cable is installed, and if terminations are not completed according to manufacturer's specific requirements.
5. Network signal integrity requires that each conductor and ground wire be correctly terminated at every connected device.
6. Segment networks shall be capable of connecting to any of the following: BACnet-compliant BAS (provided by others) directly via MS/TP, or BACnet/IP via an LMSM Unit.

## 2.10 NETWORK BRIDGE

A. Network bridge module connects a local network to a BACnet-compliant segment network for communication between rooms, relay panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. Network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver.
   1. Network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
   2. Network bridge shall automatically create standard BACnet objects for selected network devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the network devices on each local network. BACnet objects will be created for the addition or replacement of any given device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID and physical MS/TP (or Cat-5E) termination per room are not acceptable. Standard BACnet objects shall be provided as follows:
      a. Read/write the normal or after hours schedule state for the room
      b. Read the detection state of each occupancy sensor
      c. Read the aggregate occupancy state of the room
      d. Read/write the On/Off state of loads
      e. Read/write the dimmed light level of loads
      f. Read the button states of switches
      g. Read total current in amps, and total power in watts through the load controller
      h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
      i. Activate a preset scene for the room
      j. Read/write daylight sensor fade time and day and night setpoints
      k. Read the current light level, in foot-candles, from interior and exterior photosensors and photocells
      l. Set daylight sensor operating mode
      m. Read/write wall switch lock status
      n. Read watts per square foot for the entire controlled room
      o. Write maximum light level per load for demand response mode
      p. Read/write activation of demand response mode for the room
      q. Activate/restore demand response mode for the room

## 2.11 SEGMENT MANAGER

A. For networked applications, the Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser utilizing either unencrypted TCP/IP traffic via a configurable port (default is 80) or 256-bit AES encrypted SSL TCP/IP traffic via a configurable port (default is 443).

B. Each segment manager shall have integral support for at least three segment networks. Segment networks may alternately be connected to the segment manger via external BACnet-to-IP interface routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment network. Provide the quantity of routers and switches as shown on the Drawings.

C. Operational features of the Segment Manager shall include the following:
   1. Connection to PC or LAN via standard Ethernet TCP/IP via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.
   2. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or

equal browser. The Segment Manager shall not require installation of any lighting control software on an end-user PC.

3. Log in security capable of restricting some users to view-only or other limited operations.
4. Segment Manager shall provide two main sets of interface screens - those used to initially configure the unit (referred to as the config screens), and a those used to allow users to dynamic monitor the performance of their system and provide a centralized scheduling interface. Capabilities using the Config Screens shall include:
    a. Automatic discovery of networked devices and relay panels on the segment network(s). Commissioning beyond activation of the discovery function shall not be required to provide communication, monitoring or control of all local networks and lighting control panels.
    b. Allow information for all discovered networked devices to be imported into the Segment Manager via a single XML based site file from the LMCS Software. Importable information can include text descriptions of every networked component and individual loads, and automatic creation of room location information and overall structure of network. Info entered into LMCS should not have to be re-entered manually via keystrokes into the Segment Manager
    c. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.
    d. Ability to view and modify networked device operational parameters. It shall be possible to set device parameters independently for normal hours and after-hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-On or Auto-On.
    e. Provide capabilities for integration with a BAS via BACnet protocol. At a minimum, the following points shall be available to the BAS via BACnet IP connection to the segment manager: room occupancy state; room schedule mode; room switch lock control; individual occupancy sensor state; room lighting power; room plug-load power; load ON/OFF state; load dimming level; panel channel schedule state; panel relay state; and Segment Manager Group schedule state control. Any of above items shall be capable of being moved into an "Export Table" that will provide any integrator with only the data they need, and by using the Export Table effectively create a firewall between the integrator's request for info and the overall system performance.
5. Capabilities using the Segment Manager's Dashboard Screens shall include:
    a. A dynamic "tile" based interface that allows easy viewing of each individual room's lighting and plug load power consumption, and lighting and plug load power density. Tiles will be automatically organized according to location so a single tile for the building summarizes all information for tiles beneath it on every floor, in every area, in every room. Tiles use three color coded energy target parameters, allowing an owner to quickly identify rooms that are not performing efficiently. Tiles for rooms with occupancy sensors shall include an icon to indicate whether that room is occupied. Tiles shall be clickable, and when clicked the underlying hierarchical level of tiles shall become visible. Tile interface shall be accessible via mouse, or touch screen devices. Tiles shall be created automatically by the segment manager, based on the information found during the device discovery and/or information included in a file imported in from LMCS (such as tagged descriptions for each room) without any custom programming.
    b. Ability to set up schedules for local networks (rooms) and panels. Schedules shall be capable of controlling individual rooms with either on/off or normal hours/after-hours set controlled zones or areas to either a normal hours or after hours mode of operation. Support for annual schedules, holiday schedules and unique date-bound schedules, as well as astro On or astro Off events with offsets. Schedules shall be viable graphically as time bars in a screen set up to

automatically show scheduled events by day, week or month.

6. If shown on the Drawings, Segment Managers shall be integrated into a larger control network by the addition of a Network Supervisor package. The Supervisor is a server level computer running a version of the Segment Manager interface software with dedicated communication and networking capability, able to pull information automatically from each individual Segment Manager in the network. By using a Supervisor, information for individual Segment Managers can be accessed and stored on the Supervisor's hard drive, eliminating the risk of data being overwritten after a few days because of Segment Manager memory limits.
7. Segment Manager shall allow access and control of the overall system database via Native Niagara AX FOX connectivity. Systems that must utilize a Tridium Niagara controller in addition to the programming, scheduling and configuration server are not acceptable.

D. Segment Manager shall support multiple networked rooms as follows:
   1. Support up to 200 network bridges and 1,100 digital in room devices, connected via network routers and switches.

## 2.12 PROGRAMMING, CONFIGURATION AND DOCUMENTATION SOFTWARE

A. PC-native application for optional programming of detailed technician-level parameter information for all networked products, including all parameters not accessible via BACnet and the handled IR configuration tool. Software must be capable of accessing room-level parameter information globally for many segment networks simultaneously utilizing standard BACnet/IP communication.

B. Additional parameters exposed through this method include but are not limited to:
   1. Occupancy sensor detection LED disable for performance and other aesthetic spaces where blinking LEDs present a distraction.
   2. Six occupancy sensor action behaviors for each controlled load, separately configurable for normal hours and after-hours modes. Modes include: No Action, Follow Off Only, Follow On Only, Follow On and Off, Follow On Only with Override Time Delay, Follow Off Only with Blink Warn Grace Time, Follow On and Off with Blink Warn Grace Time.
   3. Separate fade time adjustments per load for both normal and after hours from 0 - 4 hours.
   4. Configurable occupancy sensor re-trigger grace period from 0 - 4 minutes separate for both normal hours and after hours.
   5. Separate normal hours and after hours per-load button mode with modes including: Do nothing, on only, off only, on and off.
   6. Load control polarity reversal so that on events turn loads off and vice versa.
   7. Per-load DR (demand response) shed level in units of percent.
   8. Load output pulse mode in increments of 1second.
   9. Fade trip point for each load for normal hours and after hours that establishes the dimmer command level at which a switched load closes its relay to allow for staggered On of switched loads in response to a dimmer.

C. Generation of reports at the whole file, partial file, or room level. Reports include but are not limited to:
   1. Device list report: All devices in a project listed by type.
   2. Load binding report: All load controller bindings showing interaction with sensors, switches, and daylighting.
   3. BACnet points report: Per room Device ID report of the valid BACnet points for a given site's BOM.
   4. Room summary report: Device manifest for each room, aggregated by common BOM, showing basic sequence of operations.

5. Device parameter report: Per-room lists of all configured parameters accessible via handheld IR programmer for use with O&M documentation.
6. Scene report: All project scene pattern values not left at defaults (i.e., 1 = all loads 100 percent, 2 = all loads 75 percent, 3 = all loads 50 percent, 4 = all loads 25 percent, 5-16 = same as scene 1).
7. Occupancy sensor report: Basic settings including time delay and sensitivities for all occupancy sensors.

D. Network-wide programming of parameter data in a spreadsheet-like programming environment including but not limited to the following operations:
1. Set, copy/paste an entire project site of sensor time delays.
2. Set, copy/paste an entire project site of sensor sensitivity settings.
3. Search based on room name and text labels.
4. Filter by product type to allow parameter set by product.
5. Filter by parameter value to search for product with specific configurations.

E. Network-wide firmware upgrading remotely via the BACnet/IP network.
1. Mass firmware update of entire rooms.
2. Mass firmware update of specifically selected rooms or areas.
3. Mass firmware upgrade of specific products

## 2.13 EMERGENCY LIGHTING CONTROL DEVICES

A. Emergency Lighting Control Unit - A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
1. 120/277 volts, 50/60 Hz, 20 amp rating
2. Push to test button
3. Auxiliary contact for remote test or fire alarm system interface

# PART 3 EXECUTION

## 3.1 PREPARATION

A. Do not begin installation until measurements have been verified and work areas have been properly prepared.

B. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Verify that the required pre-installation meeting specified in Part 1 of this specification has been completed, recorded meeting minutes have been distributed and all outstanding issues noted have been resolved prior to the start of installation.

## 3.2 INSTALLATION

A. Install system in accordance with the approved system shop drawings and manufacturer's instructions.

B. Install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors.
1. If pre-terminated cable is not used for room/area wiring, each field-terminated cable shall be tested prior to proceeding with the Work.
2. If fixtures have internal network Control Modules, ensure that they are also connected with Cat 5e cable.

3. Install all room to room network devices using MSTP network wire.
4. Low voltage wiring topology must comply with manufacturer's specifications.
5. Route network wiring as indicated on the Drawings as closely as possible. Document final wiring location, routing and topology on as built drawings.

C. All line voltage connections shall be tagged to indicate circuit and switched legs.

D. Test all devices to ensure proper communication.

E. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings. Adjust time delay so that controlled area remains lighted while occupied.

F. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
2. Sequence of operation, (e.g., manual ON, Auto OFF. etc.)
3. Load Parameters (e.g., blink warning, etc.)

G. Post start-up tuning - Adjust sensor time delays and sensitivities to meet the Owner's requirements 30 days from beneficial occupancy. Provide a detailed report to the Architect / Owner of post start-up activity.

H. All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.

I. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimming loads shall have separate neutral.

J. Verify all non-panel-based lighting loads to be free from short circuits prior to connection to room controllers.

## 3.3 FIELD QUALITY CONTROL

A. Tests and Inspections: Manufacturer's service representative shall perform the following inspections and prepare reports.
1. Verify Class I and II wiring connections are terminated properly by validating system performance.
2. Set IP addresses and other network settings of system front end hardware per facilities IT instructions.
3. Verify / complete task programming for all switches, dimmers, time clocks, and sensors.
4. Verify that the control of each space complies with the Sequence of Operation.
5. Correct any system issues and retest.

B. Provide a report in table format with drawings or using a software file that can be opened in the manufacturer's system software including each room or space that has lighting control installed. Indicate the following:
1. Date of test or inspection.
2. Loads per space, or Fixture Address identification.
3. Quantity and Type of each device installed
4. Reports providing each device's settings.

## 3.4 POST OCCUPANCY QUALITY CONTROL

A. Convene at a maximum of 30-days after beneficial occupancy. Meeting to be attended by Contractor, Architect, system installer, factory authorized manufacturer's representative, and

representative of all trades related to the system installation.

B. Post occupancy tuning - Adjust sensor time delays and sensitivities to meet the Owner's requirements. Update any adjustments to the field quality control report and return an updated copy to the Architect / Owner of any post occupancy activity.

## 3.5 SOFTWARE SERVICE AGREEMENT

a. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

b. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1) Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

## 3.6 DEMONSTRATION AND TRAINING

A. Before Substantial Completion, arrange and provide a one-day Owner instruction period to designated Owner personnel. Set-up, starting of the lighting control system and Owner instruction includes:
1. Confirmation of entire system operation and communication to each device.
2. Confirmation of operation of individual relays, switches, and sensors.
3. Confirmation of system Programming, photocell settings, override settings, etc.
4. Provide training to cover installation, programming, operation, and troubleshooting of the lighting control system.

## 3.7 PRODUCT SUPPORT AND SERVICE

A. Factory telephone support shall be available at no cost to the Owner following acceptance. Factory assistance shall consist of assistance in solving application issues pertaining to the control equipment.

**END OF SECTION 260943**

# SECTION 262416 - PANELBOARDS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

### 1.2 DEFINITIONS

A. MCCB: Molded-case circuit breaker.

B. SPD: Surge protective device.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Include evidence of NRTL listing for SPD as installed in panelboard.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include wiring diagrams for power, signal, and control wiring.
9. Key interlock scheme drawing and sequence of operations.
10. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.

### 1.4 INFORMATIONAL SUBMITTALS

A. Panelboard schedules for installation in panelboards.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.

D. Enclosures: Flush and/or Surface-mounted, as indicated on Drawings, dead-front cabinets.

1. Rated for environmental conditions at installed location.
   a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
   b. Outdoor Locations: NEMA 250, Type 3R.
   c. **Kitchen or Wash-Down** Areas: NEMA 250, Type 3R.
   d. Wet or Damp Indoor Locations: NEMA 250, Type 4.
   e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
2. Height: 84 inches (2.13 m) maximum.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.

E. Phase, Neutral, and Ground Buses: Tin-plated aluminum or Silver-plated hard-drawn copper, 98 percent conductivity.

F. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated aluminum or Silver-plated hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression or Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
3. Ground Lugs and Bus-Configured Terminators: Compression or Mechanical type, with a lug on the bar for each pole in the panelboard.
4. Feed-Through Lugs: Compression or Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Compression or Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

G. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices.

H. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

## 2.2 PERFORMANCE REQUIREMENTS

A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1 or Type 2.

## 2.3 POWER PANELBOARDS

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

1. Square D, a division of Schneider Electric
2. G.E., a division of ABB
3. Siemens Energy & Automation, Inc.
4. Eaton Corporation, Cutler-Hammer Products

B. Panelboards: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

## 2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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

1. Square D, a division of Schneider Electric
2. G.E., a division of ABB
3. Siemens Energy & Automation, Inc.
4. Eaton Corporation, Cutler-Hammer Products

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

## 2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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

1. Square D, a division of Schneider Electric
2. G.E., a division of ABB
3. Siemens Energy & Automation, Inc.
4. Eaton Corporation, Cutler-Hammer Products

B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:
   a. Inverse time-current element for low-level overloads.
   b. Instantaneous magnetic trip element for short circuits.
   c. Adjustable magnetic trip setting for circuit-breaker frame sizes 200 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:
   a. RMS sensing.
   b. Field-replaceable rating plug or electronic trip.
   c. Digital display of settings, trip targets, and indicated metering displays.
   d. Multi-button keypad to access programmable functions and monitored data.
   e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
   f. Integral test jack for connection to portable test set or laptop computer.
   g. Field-Adjustable Settings:
      1) Instantaneous trip.
      2) Long- and short-time pickup levels.
      3) Long and short time adjustments.
      4) Ground-fault pickup level, time delay, and I squared T response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Breaker handle indicates tripped status.
   c. UL listed for reverse connection without restrictive line or load ratings.
   d. Lugs: Compression or Mechanicalstyle, suitable for number, size, trip ratings, and conductor materials.
   e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
   f. Ground-Fault Protection: Integrally mounted or Remote-mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   g. Communication Capability: Circuit-breaker-mounted, Universal-mounted, or Din-rail-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
   h. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

## 2.6 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Comply with NECA 1.

B. Install panelboards and accessories according to NECA 407.

C. Mount panels at height above finished floor so that no operating handle of switch or circuit breaker in the on position is higher than 79 inches (2000 mm).

D. Mount panelboard cabinet plumb and rigid without distortion of box.

E. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

F. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.

G. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

H. Install filler plates in unused spaces.

I. Stub four 1-inch (27-EMT) empty conduits from panelboard into accessible ceiling space if so constructed or space designated to be ceiling space in the future. Stub four 1-inch (27-EMT) empty conduits into raised floor space or below slab not on grade.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

## 3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in "Identification for Electrical Systems."

E. Install warning signs complying with requirements in "Identification for Electrical Systems" identifying source of remote circuit.

## 3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

**END OF SECTION 262416**

# SECTION 262726 - WIRING DEVICES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Standard-grade receptacles, 125 V, 20 A.
2. USB receptacles.
3. GFCI receptacles, 125 V, 20 A.
4. SPD receptacles, 125 V, 20 A.
5. Twist-locking receptacles.
6. Toggle switches.
7. Wall-box dimmers.
8. Wall plates.
9. Floor service fittings.

### 1.3 DEFINITIONS

A. BAS: Building automation system.

B. EMI: Electromagnetic interference.

C. GFCI: Ground-fault circuit interrupter.

D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

E. RFI: Radio-frequency interference.

F. SPD: Surge protective device.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.7 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. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.
2. SPD Receptacles: One for every 10 of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Wiring Devices:

1. Bryant Electric, Inc., Hubbell Subsidiary.
2. Eagle Electric Manufacturing Co.
3. Hubbell Incorporated; Wiring Device-Kellems.
4. Leviton Mfg Company
5. Pass & Seymour/Legrand; Wiring Devices Div.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Essential Electrical System: Red.

3. SPD Devices: Blue.

F. Wall Plate Color: For plastic covers, match device color.

G. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

## 2.3 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

A. Duplex Receptacles, 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498 and FS W-C-596.

B. Tamper-Resistant Duplex Receptacles, 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498 and FS W-C-596.
4. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

C. Weather-Resistant Duplex Receptacle, 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498.
4. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

## 2.4 USB RECEPTACLES

A. USB Charging Receptacles:

1. Description: Single piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
2. USB Receptacles: Dual, USB Type A and Type-C, 5 V dc, and 2.4 A per receptacle (minimum).
3. Standards: Comply with UL 1310 and USB 3.0 devices.

B. Tamper-Resistant Duplex and USB Charging Receptacles:

1. Description: Single piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap. Integral shutters that operate only when a plug is inserted in the line voltage receptacle.
2. Line Voltage Receptacles: Two pole, three wire, and self-grounding; NEMA WD 6, Configuration 5-20R.
3. USB Receptacles: Dual, USB Type A and Type-C, 5 V dc, and 2.4 A per receptacle (minimum).
4. Standards: Comply with UL 498, UL 1310, USB 3.0 devices, and FS W-C-596.

5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

## 2.5 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A:

1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Type: Non-feed through.
4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

B. Tamper-Resistant Duplex GFCI Receptacles, 125 V, 20 A:

1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Type: Non-feed through.
4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

C. Tamper- and Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 A:

1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Type: Non-feed through.
4. Standards: Comply with UL 498 and UL 943 Class A.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

D. Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 A:

1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Type: Non-feed through.
4. Standards: Comply with UL 498 and UL 943 Class A.
5. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" article.

## 2.6 SPD RECEPTACLES, 125 V, 20 A

A. Duplex SPD Receptacles, 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding. Integral SPD in line to ground, line to neutral, and neutral to ground. LED indicator light.

2. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
3. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
4. Configuration: NEMA WD 6, Configuration 5-20R.
5. Standards: Comply with NEMA WD 1, UL 498, UL 1449, and FS W-C-596.

## 2.7 TWIST-LOCKING RECEPTACLES

A. Twist-Lock, Single Receptacles, 250 V, 20 A,30A, 50A, and 60A (as indicated on drawings):

1. Configuration: As indicated on drawings or to match equipment plug.
2. Standards: Comply with UL 498.

## 2.8 TOGGLE SWITCHES, 120/277 V, 20 A

A. Two-Pole Switches, 120/277 V, 20 A: Comply with UL 20 and FS W-S-896.

B. Three-Way Switches, 120/277 V, 20 A: Comply with UL 20 and FS W-S-896.

C. Four-Way Switches, 120/277 V, 20 A: Standards: Comply with UL 20 and FS W-S-896.

D. Lighted Single-Pole Switches, 120/277 V, 20 A:

1. Description: Handle illuminated when switch is off.
2. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

## 2.9 DIMMERS

A. Wall-Box Dimmers:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: Modular, full-wave, solid-state dimmer switch with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
3. Control: Continuously adjustable slider; with single-pole or three-way switching.
4. Standards: Comply with UL 1472.
5. Retain "Incandescent Lamp Dimmers," "Fluorescent Lamp Dimmer Switches," or "LED Lamp Dimmer Switches" Subparagraph below. Coordinate dimmer type with lamp type.

6. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module, dimmers shall require no derating when ganged with other devices.
7. LED Lamp Dimmer Switches: Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 5 percent of full brightness.

## 2.10 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: 0.035-inch- (1-mm-) thick, satin-finished, Type 302 stainless steel.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, thermoplastic with lockable while in-use cover.

## 2.11 FLOOR SERVICE FITTINGS

A. Above-Floor Service Fittings:

1. Description: Type: Modular, above-floor, dual-service units suitable for wiring method used.
2. Service Plate: Rectangular satin finish.
3. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan-speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on bottom. Group adjacent switches under single, multigang wall plates.

## 3.2 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

## 3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

C. Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using a self-adhesive label.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. In healthcare facilities, prepare reports that comply with NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

**END OF SECTION 262726**

# SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

### 1.2 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

D. DPST: double pole single throw

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF and SKM electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

1. Include the following:

a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF and SKM format electronic format.

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.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2010 m).

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year(s) from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

### 2.2 MANUFACTURERS

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

1. Square D, a division of Schneider Electric
2. G.E., a division of ABB
3. Siemens Energy & Automation, Inc.
4. Eaton Corporation, Cutler-Hammer Products

### 2.3 NONFUSIBLE SWITCHES

A. Type GD, General Duty, Three Pole, Single Throw, 240-V ac, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Hookstick Handle: Allows use of a hookstick to operate the handle.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

### 2.4 SHUNT TRIP SWITCHES

A. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with Class J fuse block and 200-kA interrupting and short-circuit current rating.

B. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: 600-V ac, 100A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to

accommodate specified fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

C. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: 600-V ac, 100A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, pilot, indicating and control devices.

E. Accessories:

1. Oiltight key switch for key-to-test function.
2. Oiltight red ON pilot light.
3. Isolated neutral lug; 100 percent rating.
4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
5. Form C alarm contacts that change state when switch is tripped.
6. Three-pole, double-throw, fire-safety and alarm relay; 120-V ac coil voltage.
7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.
8. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
9. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
10. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
11. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating – as required.
12. Hookstick Handle: Allows use of a hookstick to operate the handle.
13. Lugs: Mechanical type, suitable for number, size, and conductor material.
14. Service-Rated Switches: Labeled for use as service equipment.

## 2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1) or gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 3R, 12).

C. Operating Mechanism: The circuit-breaker operating handle shall be directly operable through the front cover of the enclosure (NEMA 250 Type 1) or directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

### 3.2 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.

### 3.3 INSTALLATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NFPA 70 and NECA 1.

### 3.4 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

### 3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that the unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

D. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

   a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
   b. Inspect physical and mechanical condition.
   c. Inspect anchorage, alignment, grounding, and clearances.
   d. Verify that the unit is clean.
   e. Operate the circuit breaker to ensure smooth operation.
   f. Inspect bolted electrical connections for high resistance using one of the two following methods:

      1) Use a low-resistance ohmmeter.

         a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

      2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

         a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

   g. Inspect operating mechanism, contacts, and chutes in unsealed units.
   h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
   b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
   c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
   d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
   e. Determine the following by primary current injection:

      1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

## 3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges.

**END OF SECTION 26 28 16**

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# SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes lightning protection system for the following:

1. Ordinary structures.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
2. Include raceway locations needed for the installation of conductors.
3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
4. Include roof attachment details, coordinated with roof installation.
5. Calculations required by NFPA 780 for bonding of metal bodies.

### 1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, coordinated with each other, using input from installers of the items involved:

B. Qualification Data: For Installer.

C. Product certificates.

D. Field quality-control reports.

### 1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1. Include the following:

a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations. Comply with requirements of Section 017839 "Project Record Documents."
b. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.

B. Completion Certificate:

1. UL Master Label Certificate.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications: LPI Master Installer.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. < Automatic Lightning Protection.
B. ERICO International Corporation.
C. Harger Lightning Protection, Inc.
D. Heary Bros. Lightning Protection Co. Inc.
E. Robbins Lightning Inc.
F. Thompson Lightning Protection, Inc.

## 2.2 PERFORMANCE REQUIREMENTS

A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I buildings.

B. UL Lightning Protection Standard: Comply with UL 96A requirements for Class I buildings.

C. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

## 2.3 MATERIALS

A. Air Terminals:

1. Aluminum unless otherwise indicated.
2. 5/8-inch (16-mm) diameter by 24 inches (610 mm) long.
3. Rounded tip.
4. Threaded base support.

B. Class 1 Main Conductors:

1. Aluminum: 98,600 circular mils in diameter.

C. Secondary Conductors:

1. Aluminum: 41,400 circular mils in diameter.

D. Ground Rods:

1. Material: Copper-clad steel.
2. Diameter: 3/4 inch (19 mm).
3. Rods shall be not less than 240 inches (6096 mm) long.
4. Sectional type, with integral threads.

E. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A.

B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches (203 mm) in radius and narrow loops.

C. Conceal conductors within normal view from exterior locations at grade within 200 feet (60 m) of building. Comply with requirements for concealed systems in NFPA 780.

1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
2. Install conduit where necessary to comply with conductor concealment requirements.

### 3.2 CONNECTIONS

A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.

B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: exothermic weld.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

### 3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

## 3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Perform inspections as required to obtain a UL Master Label for system.

B. Prepare test and inspection reports and certificates.

**END OF SECTION 264113**

# SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes:

1. Type 1 surge protective devices.
2. Type 2 surge protective devices.
3. Enclosures.
4. Conductors and cables.

B. Related Requirements:
1. Section 262416 "Panelboards" for integral SPDs installed by panelboard manufacturer.
2. Section 262726 "Wiring Devices" for integral SPDs installed by receptacle manufacturer.

### 1.2 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: air of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. NRTL: Nationally recognized testing laboratory.

F. OCPD: Overcurrent protective device.

G. SCCR: Short-circuit current rating.

H. SPD: Surge protective device.

I. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.

J. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.

K. Type 3 SPDs: Point of utilization SPDs.

L. VPR: Voltage protection rating.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include electrical characteristics, specialties, and accessories for SPDs.
2. NRTL certification of compliance with UL 1449.

    a. Tested values for VPRs.
    b. Inominal ratings.
    c. MCOV, type designations.
    d. OCPD requirements.
    e. Manufacturer's model number.
    f. System voltage.
    g. Modes of protection.

## 1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special warranty.

## 1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

## 1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace SPDs that fail in materials or workmanship within five years from date of Substantial Completion.

# PART 2 - PRODUCTS

## 2.1 TYPE 1 SURGE PROTECTIVE DEVICES (SPDs)

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

1. APT, a division of Schneider Electric
2. SSI, an ILSCO Company
3. Siemens Energy & Automation, Inc.
4. Eaton Corporation, Cutler-Hammer Products
5. G.E., a division of ABB

B. Source Limitations: Obtain devices from single source from single manufacturer.

C. Standards:

1. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1.

D. Product Options:

1. Include integral disconnect switch.

2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include indicator light display for protection status.
4. Include audible alarm.
5. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V ac for remote monitoring of protection status.
6. Include surge counter.

E. Performance Criteria:

1. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
2. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 200 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
3. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits must not exceed the following:

    a. Line to Neutral: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
    b. Line to Line: 2000 V for 480Y/277 V or 1200 V for 208Y/120 V.

4. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:

    a. Line to Neutral: 700 V.
    b. Line to Line: 1200 V.

5. SCCR: Not less than 200 kA.
6. Inominal Rating: 20 kA.

## 2.2 TYPE 2 SURGE PROTECTIVE DEVICES (SPDs)

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

1. APT, a division of Schneider Electric
2. SSI, an ILSCO Company
3. Siemens Energy & Automation, Inc.
4. Eaton Corporation, Cutler-Hammer Products
5. G.E., a division of ABB

B. Source Limitations: Obtain devices from single source from single manufacturer.

C. Standards:

1. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 2.
2. Comply with UL 1283.

D. Product Options:

1. Include LED indicator lights for power and protection status.

2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V ac for remote monitoring of protection status.
4. Include surge counter.

E. Performance Criteria:

1. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
2. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 150 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
3. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits must not exceed the following:

    a. Line to Neutral: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
    b. Line to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
    c. Neutral to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
    d. Line to Line: 2000 V for 480Y/277 V or 1200 V for 208Y/120 V.

4. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:

    a. Line to Neutral: 700 V.
    b. Line to Ground: 700 V.
    c. Neutral to Ground: 700 V.
    d. Line to Line: 1200 V.

5. SCCR: Equal or exceed 200 kA.
6. Inominal Rating: 10 kA.

## 2.3 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

B. Outdoor Enclosures: NEMA 250, Type 3R or Type 4X.

## 2.4 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Comply with NECA 1.

B. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's written instructions.

C. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's written instructions. Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
2. Do not exceed manufacturer's recommended lead length.
3. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

## 3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. SPDs that do not pass tests and inspections will be considered defective.

C. Prepare test and inspection reports.

## 3.3 STARTUP SERVICE

A. Complete startup checks in accordance with manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

## 3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to operate and maintain SPDs.

**END OF SECTION 264313**

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# SECTION 265119 - LED INTERIOR LIGHTING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes interior only LED luminaires:

B. Related Requirements:

1. Section 260943 "Distributed Intelligence Based Lighting Controls" for automatic control of lighting.
2. Section 260943.23 "Relay Based Lighting Controls" for automatic control of lighting.

### 1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.

a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.

6. Wiring diagrams for power, control, and signal wiring.
7. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

## 1.5 INFORMATIONAL SUBMITTALS

A. Sample warranty.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all types used on Project; use ANSI and manufacturers' codes.

## 1.7 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. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
2. Globes and Guards: One for every 50 of each type and rating installed. Furnish at least one of each type.

## 1.8 QUALITY ASSURANCE

A. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

B. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Ambient Temperature: 41 to 104 deg F (5 to 40 deg C).

B. Altitude: Sea level to 1000 feet (300 m).

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-Applied Labels: Comply with UL 1598. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp module characteristics:

a. Manufacturer

b. Model number

c. CCT and CRI.

C. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

D. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

E. Luminaire CRI requirements: Greater than **80 CRI** unless noted otherwise on Drawings.

F. Luminaire CCT requirements: **4000K** unless noted otherwise on Drawings.

G. Luminaire Lumen outputs: As indicated on Drawings or comparable with luminaire model specified on Drawings.

H. Luminaire Rated Lamp Life: As comparable with luminaire model specified on Drawings.

I. Nominal Operating Voltage: 120 V ac through 277 V ac, or as indicated on Drawings.

1. Dimmable from 100 percent to 10 percent of maximum light output.
2. Internal driver.

J. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

K. Lens Thickness (if applicable): At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

L. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. Recessed luminaires shall comply with NEMA LE 4.
4. UL Listing: Listed for damp or wet location as indicated on drawings and in part numbers specified on the drawings.
5. Industrial luminaires Class 1, Division 2 Group.
6. Ratings below as indicated on drawings and in part numbers specified on the drawings:
   a. NEMA 4X
   b. IP 54
   c. IP 66
   d. IP 67

## 2.3 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for sheet steel.

C. Stainless Steel:

1. 1. Manufacturer's standard grade.
2. 2. Manufacturer's standard type, ASTM A240/240M.

D. Galvanized Steel: ASTM A653/A653M.

E. Aluminum: ASTM B209.

## 2.4 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

## 2.5 LUMINAIRE SUPPORT

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: Minimum 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

D. Flush-Mounted Luminaires:

1. Secured to outlet box.

2. Attached to ceiling structural members at two points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

E. Wall-Mounted Luminaires:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

F. Suspended Luminaires:

1. Pendants, Aircraft Cable and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of two (four) locations, spaced near corners of luminaire and connected directly to structure.

H. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

## 3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

## 3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

## 3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

**END OF SECTION 265119**

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# SECTION 265213 - EMERGENCY AND EXIT LIGHTING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Emergency lighting units.
2. Exit signs.
3. Luminaire supports.

### 1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Fixture: See "Luminaire" Paragraph.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.

1. Include data on features, accessories, and finishes.
2. Include physical description of the unit and dimensions.
3. Battery and charger for light units.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Product Schedule:

1. For emergency lighting units.
2. For exit signs.

## 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and 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. Luminaire-mounted, emergency battery pack: One for every 50 emergency lighting units. Furnish at least one of each type.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

## 1.8 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five year(s) from date of Substantial Completion.

B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Power Unit Batteries: Five years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.
2. Warranty Period for Self-Powered Exit Sign Batteries: Five years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.

# PART 2 - PRODUCTS

## 2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

C. Comply with NFPA 70 and NFPA 101.

D. Comply with NEMA LE 4 for recessed luminaires.

E. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.

1. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
2. Battery: Sealed, maintenance-free, nickel-cadmium type.
3. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
4. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

F. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.

1. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
2. Battery: Sealed, maintenance-free, nickel-cadmium type.
3. Charger: Fully automatic, solid-state, constant-current type.
4. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the distance recommended by the driver or emergency power unit manufacturer, whichever is less.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

## 2.2 EMERGENCY LIGHTING

A. Emergency Luminaires:

1. Emergency Luminaires: Interior Luminaire Schedule and Drawings.

a. Operating at nominal voltage of 120 V ac or 277 V ac
b. Internal or External emergency power unit.
c. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.
d. UL 94 flame rating.

B. Emergency Lighting Unit:

1. Emergency Lighting Unit: Interior Luminaire Schedule and Drawings.
2. Operating at nominal voltage of 120 V ac or 277 V ac
3. Wall or Ceiling mount as indicated on drawings, with universal junction box adaptor.
4. UV stable thermoplastic housing.
5. Two lamp heads.
6. Internal emergency power unit.

C. Remote Emergency Lighting Units:

1. Emergency Lighting Unit: As indicated on Interior Luminaire Schedule and Drawings.
2. Operating at nominal voltage of 120 V ac or 277 V ac
3. Wall or Ceiling mount as indicated on drawings, with universal junction box adaptor.
4. UV stable thermoplastic housing.
5. LED lamp heads.
6. External emergency power unit.

## 2.3 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Operating at nominal voltage of 120 V ac or 277 V ac
2. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
3. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

## 2.4 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Housings:

1. Extruded aluminum or Thermoplastic housing, as indicated on drawings.
2. Clear finish.

D. Conduit: Electrical metallic tubing, minimum 3/4 inch (21 mm) in diameter.

## 2.5 METAL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## 2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Support Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

## 3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

## 3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

## 3.5 STARTUP SERVICE

A. Perform startup service:

1. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.

## 3.6 ADJUSTING

A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:

1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.

a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

2. Conduct short-duration tests on all emergency lighting.

**END OF SECTION 265213**

# SECTION 265613 - LIGHTING POLES AND STANDARDS

## 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. Poles and accessories for support of luminaires.

### 1.3 DEFINITIONS

A. EPA: Equivalent projected area.

B. Luminaire: Complete luminaire.

C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.

D. Standard: See "Pole."

### 1.4 ACTION SUBMITTALS

A. Product Data: For each pole, accessory, and luminaire-supporting device, arranged as indicated.

1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
2. Include finishes for lighting poles and luminaire-supporting devices.
3. Anchor bolts.
4. Manufactured pole foundations.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of poles and pole accessories.
4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
6. Method and procedure of pole installation. Include manufacturer's written installations.

## 1.5 INFORMATIONAL SUBMITTALS

A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements according to AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations signed and sealed by a professional engineer.

B. Material Test Reports:

1. For each foundation component, by a qualified testing agency.
2. For each pole, by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranty: Manufacturer's standard warranty.

E. Soil test reports

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For poles to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include pole inspection and repair procedures.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Pole repair materials.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B660.

B. Store poles on decay-resistant skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on poles until right before pole installation. Handle poles with web fabric straps.

## 1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of poles that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.

1. Warranty Period: Five years from date of Substantial Completion.
2. Warranty Period for Corrosion Resistance: Five years from date of Substantial Completion.

3. Warranty Period for Color Retention: 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 pole foundation and pole power system.

B. Structural Characteristics: Comply with AASHTO LTS-6-M.

C. Dead Load: Weight of luminaire and its horizontal and vertical supports, and supporting structure, applied according to AASHTO LTS-6-M.

D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.

1. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is 150 mph (68 m/s).

a. Wind Importance Factor: 1.0
b. Minimum Design Life:25 years
c. Velocity Conversion Factor: 1.0

E. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.

1. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is 150 mph (68 m/s).

a. Risk Category: As determined by FBC Table 1604.5
b. Minimum Design Life:25 years
c. Wind Load: Ultimate Design Wind Speed as calculated using FBC Section 1609.

F. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.3 to obtain the EPA to be used in pole selection strength analysis.

G. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

### 2.2 ALUMINUM POLES

A. Poles: extruded structural tube complying with ASTM B221, with access handhole in pole wall.

1. Shape: Round, tapered.
2. Mounting Provisions: Butt flange for bolted mounting on foundation.

B. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

C. Grounding and Bonding Lugs: Bolted 1/2-inch (13-mm) threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for

attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

D. Fasteners: Stainless steel size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1. Materials: Compatible with poles and standards as well as to substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

E. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws.

F. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I clear coating of 0.018 mm or thicker), complying with AAMA 611.
4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

G. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

    a. Color: As selected by Architect from manufacturer's full range.

H. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Powder coat shall comply with AAMA 2604.

a. Electrostatic applied powder coating; single application with a minimum 2.5- to 3.5-mils (64- to 89-um) dry film thickness; cured according to manufacturer's instructions. Coat interior and exterior of pole for equal corrosion protection.
b. Color: Black, or as selected by Architect from manufacturer's full range.

## 2.3 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.

## 2.4 MOUNTING HARDWARE

A. Anchor Bolts: Manufactured to ASTM F1554, Grade 55, with a minimum yield strength of 55,000 psi (380 000 kPa).

1. Galvanizing: Hot dip galvanized according to ASTM A153, Class C.
2. Headed rods 7/8”inches (22mm) in diameter by 18 inches (457mm) in length.
3. Threading: Uniform National Coarse Class 2A.

B. Nuts: ASTM A563, Grade A, Heavy-Hex.

1. Galvanizing: Hot dip galvanized according to ASTM A153, Class C.
2. Two nuts provided per anchor bolt.

C. Washers: ASTM F436, Type 1.

1. Galvanizing: Hot dip galvanized according to ASTM A153, Class C.
2. Two washer(s) provided per anchor bolt.

## 2.5 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine poles, luminaire-mounting devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.

C. Examine roughing-in for foundation and conduit to verify actual locations of installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 POLE FOUNDATION

Cast Concrete Pole foundations may utilize any of the two options below.

A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A36/A36M and hot-dip galvanized according to ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Pre-Cast Foundations: Factory fabricated, with structural steel complying with ASTM A36/A36M and hot-dip galvanized according to ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

C. Direct-Buried Foundations: Install to depth indicated on Drawings, but not less than one-sixth of pole height. Add backfill as shown on Drawings. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.

D. Direct-Buried Poles with Concrete Backfill: Set poles in augered holes to depth as indicated on Drawings, but not less than one-sixth of pole height. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.

1. Make holes 6 inches (150 mm) in diameter larger than pole diameter.
2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi (20 MPa) at 28 days and finish in a dome above finished grade.
3. Use a short piece of 1/2-inch (13-mm) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
4. Cure concrete a minimum of 72 hours before performing work on pole.

E. Anchor Bolts: Install plumb using manufacturer-supplied template, uniformly spaced.

## 3.3 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.

1. Fire Hydrants and Water Piping: 60 inches (1520 mm).
2. Water, Gas, Electric, Communications, and Sewer Lines: 10 feet (3 m).
3. Trees: 15 feet (5 m) from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.

1. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
2. Install base covers unless otherwise indicated.
3. Use a short piece of 1/2 -inch (13-mm) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

## 3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.

B. Steel Conduits: Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

## 3.5 GROUNDING

A. Ground Metal Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground Nonmetallic Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundation.

## 3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

**END OF SECTION 265613**

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# SECTION 265619 – LED EXTERIOR LIGHTING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire supports.
3. Luminaire-mounted photoelectric relays.

B. Related Requirements:

1. Section 260943 "Distributed Intelligence Based Lighting Controls" for automatic control of lighting.
2. Section 265613 "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.

### 1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. LED: Light-emitting diode.

E. IP: International Protection or Ingress Protection Rating.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.

4. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.

    a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.

5. Wiring diagrams for power, control, and signal wiring.
6. Photoelectric relays.
7. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

## 1.5 INFORMATIONAL SUBMITTALS

A. Sample warranty.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and photoelectric relays to include operation and maintenance manuals.

## 1.7 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. Diffusers and Lenses: One for every 50 of each type and rating installed.
2. Globes and Guards: One for every 50 of each type and rating installed.

## 1.8 QUALITY ASSURANCE

A. Provide luminaires from a single manufacturer for each luminaire type.

B. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

## 1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including luminaire support components.
b. Faulty operation of luminaires and accessories.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: (2) Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Ambient Temperature: 41 to 104 deg F (5 to 40 deg C).

B. Altitude: Sea level to 1000 feet (300 m).

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. UL Compliance: Comply with UL 1598 and U.L. Listed for wet location if indicated.

D. Luminaire CRI: Minimum of 70 CRI unless noted otherwise or is specific to wildlife lighting requirements.

E. Luminaire CCT: 4000K unless noted otherwise on Drawings or is specific to wildlife lighting requirements.

F. Luminaire Rated Lamp Life: As comparable with luminaire model specified on Drawings.

G. Internal driver.

H. Nominal Operating Voltage: 120 V ac or 208 V ac.

I. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. Recessed luminaires shall comply with NEMA LE 4.
4. UL Listing: Listed for damp or wet location as indicated on drawings and in part numbers specified on the drawings.
5. Industrial luminaires Class 1, Division 2 Group.
6. Ratings below as indicated on drawings and in part numbers specified on the drawings:
   a. NEMA 4X
   b. IP 54
   c. IP 66
   d. IP 67

## 2.3 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Corrosion-resistant aluminum or Stainless steel. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

E. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

F. Factory-Applied Labels: Comply with UL 1598. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles where located in place.

1. Label shall include the following characteristics:

   a. CCT and CRI for all luminaires.

## 2.4 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

a. Color: As selected from manufacturer's standard catalog of colors.

D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: As selected from manufacturer's standard catalog of colors.

## 2.5 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Fasten luminaire to structural support.

C. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

D. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

E. Wiring Method: Install cables in raceways. Conceal raceways and cables.

F. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at heights as indicated on Drawings.

G. Coordinate layout and installation of luminaires with other construction.

H. Adjust luminaires that require field adjustment or aiming.

I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

## 3.3 BOLLARD LUMINAIRE INSTALLATION:

A. Align units for optimum directional alignment of light distribution.

1. Install on concrete base with top 6 inches above finished grade or surface at luminaire location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

## 3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Install on concrete base with top 6 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

## 3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

## 3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

## 3.7 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

B. Luminaire will be considered defective if it does not pass tests and inspections.

## 3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

**END OF SECTION 265619**

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# SECTION 27 00 00 - COMMUNICATIONS STRUCTURED CABLING SYSTEM

## PART 1 – GENERAL

### 1.1 CONTRACTOR QUALIFICATIONS

The Structured Cabling System Contractor shall be an experienced firm regularly engaged in the layout and installation of structured cabling systems of similar size and complexity as required for this installation. The Structured Cabling System Contractor, under the same company name, shall have successfully completed the layout, installation, testing and warranty of not less than five Structured Cabling Systems of the scope of the largest system on this project for a minimum period of three years prior to the bid date, and shall have been regularly engaged in the business of Structured Cabling Systems contracting continuously since. The Structured Cabling System Contractor shall have an existing permanent office located within 100 miles of the job site from which installation and warranty service operations will be performed.

The Structured Cabling System Contractor shall have a BICSI Registered Communications Distribution Designer (RCDD) on staff who is a permanent employee of the company. The RCDD shall be in responsible charge of the project from start to finish.

The Structured Cabling System Contractor shall be in good standing with the Structured Cabling System Manufacturer as a Belden Certified Installer. The Structured Cabling System Contractor shall complete the Structured Cabling System Manufacturer's Certified Installer training program. The Structured Cabling System Manufacturer shall require that not less than two permanent employees of the Structured Cabling System Contractor complete the full certification program. Each Certified Installer shall attend re-certification classes every two years. The Structured Cabling System certified employees shall include not less than one designer and one installation supervisor. The Structured Cabling System Contractor shall present, with his bid, the names and credentials of the Belden certified installers who will be responsible for this project.

A. Contractor Qualifications – Conduit Installation:

All conduit and related work shall be provided by a licensed electrical contractor using tradesmen who are skilled and experienced in the types of conduit installations indicated in the bid documents.

B. Definitions

CM - Construction
Manager DB - Design
Build Contractor GC -
General Contractor

Where the three terms CM, DB, and GC are used in the specifications and TEL drawings they are used interchangeably. The Contractor shall understand the terms to mean the construction entity in overall charge of the project, whether a CM, DB or GC.

### 1.2 PROOF OF CONTRACTOR QUALIFICATIONS

The Structured Cabling System Contractor shall provide the following documentation, to be presented with his bid to the GC and following bids to the Owner within three working days of a request, as evidence that the requirements for Structured Cabling System Contractor qualifications listed above are satisfied. The Structured Cabling System Contractor shall meet the requirements of this specification section for structured cabling system work. All work under this section shall be performed by permanent employees of the Structured Cabling System Contractor listed on the bid form, and shall not be performed by another subcontractor, employees of another company, or by temporary employees. The only exceptions to these requirements shall be for conduit work, which may be performed by an electrical contractor meeting the minimum requirements of paragraph 1.1.A. Under no circumstances shall temporary employees be used for any work for these systems.

A. Provide a list of not less than five (5) references for jobs of similar size and complexity including project name, location, contact person and phone number.

B. Provide RCDD name, BICSI certification number, and qualifications.

C. Provide location of existing permanent office from which installation and warranty work will be performed.

D. Provide copies of certificates issued by Structured Cabling System Manufacturer proving that the Structured Cabling System Contractor is in good standing with Belden as a Certified Installer, and that the Structured Cabling System Contractor can offer the Owner a 25 year system warranty in partnership with the Structured Cabling System Manufacturer.

1.3 RELATED REQUIREMENTS

Drawings and general provisions of Contract apply to this section.

Electrical Specification Sections regarding conduit and raceway apply to work under this section, with the additions and modifications specified herein and on the TEL drawings. The special requirements indicated on the TEL drawings and in this specification section for structured cabling system conduit and all cable pathways shall take precedence over any requirements specified in Electrical Specification Sections.

1.4 DESCRIPTION OF WORK

The work consists of all labor, materials, equipment and services necessary to provide, install, test and certify all systems as described in the contract documents. The Structured Cabling System Contractor shall provide systems complete and ready for operation. The installation shall include all accessories and appurtenances required to provide a complete and operational system. Any materials not specifically mentioned in these specifications or not shown on the drawings but required for a complete and finished installation shall be furnished and installed at no additional cost to the Owner.

A. Special Warranty – Structured Cabling System:

The Structured Cabling System Contractor and The Structured Cabling System Manufacturer shall provide a 25 year warranty for the completed Structured Cabling System. The 25 year warranty shall commence on the date of Final Completion and Final Acceptance by the Engineer and the Owner.

The installed system shall be manufacturer certified and shall meet or exceed all performance criteria established by TIA/EIA Category 6 and Category 6A standards for unshielded UTP cabling. The electrical performance of all UTP cabling shall be characterized to 250 MHz for Category 6 cable and to 500 MHz for Category 6A cable and shall be proven by field testing of the Permanent Link.

The 25 year warranty shall cover the Structured Cabling System end-to-end and shall include parts and labor costs for replacement of defective parts or installation. The warranty shall also cover current applications plus all future applications approved to run on Category 6 and Category 6A cabling systems. The performance parameters guaranteed by The Structured Cabling System Manufacturer in published literature shall be based on worst case testing of a channel configuration using a 100 meter model constructed using four connection points consisting of a horizontal cross-connect, a consolidation point and a work area outlet.

The Structured Cabling System Contractor shall test all Category 6 and Category 6A cabling for the Permanent Link in strict accordance with TIA standards. The test results shall indicate that each cable achieved a PASS rating without exception.

The Structured Cabling System Contractor shall provide all necessary documentation to the Structured Cabling System Manufacturer required to properly register the system with the manufacturer for warranty purposes.

B. Scheduling:

The Structured Cabling System Contractor shall become thoroughly familiar with the overall project schedule and shall complete his work and make all systems fully operational prior to the date of occupancy of the facilities by the Owner.

The Structured Cabling System Contractor shall coordinate all work with the General Contractor and the Electrical Contractor, as well as all other trades.

The Structured Cabling System Contractor shall be responsible for coordinating all work related to cable pathways indicated on the TEL sheets, even if that work is being performed by the project electrical contractor. The Structured Cabling System Contractor shall inform the General Contractor if:

1) The conduit work is not being completed in accordance with the requirements indicated on the TEL drawings and this specification.

2) The conduit work is not being completed in such a manner that will allow the Structured Cabling System Contractor to complete his work in a timely manner in accordance with the project schedule and this section

The Structured Cabling System Contractor shall provide adequate training of the Owner's forces prior to the date of occupancy and shall provide follow-up training after occupancy. Total training time shall be as prescribed by this specification is considered a minimum requirement.

## 1.5 EXAMINATION OF SITES AND TOTAL SYSTEM RESPONSIBILITY

Prior to providing a proposal for this work, the Contractor shall visit the proposed site of work to become familiar with any condition that may affect the work to be performed in any way. No allowances shall be made because of lack of knowledge of these conditions.

The Contractor shall have total system responsibility to assure a fully operational system. Any additional labor and components required for the installation of complete operating systems but not specifically required by the bid documents shall be provided and the cost borne by the Contractor.

The Contractor shall remain the sole owner of the system and all of its components provided under this contract and is responsible for all risk of loss or damage of the system for the entire contract period up to and including the date and time of Final Acceptance by the Engineer and the Owner's Project Manager. After the date of Final Acceptance, the Owner shall assume full ownership of the system with all components, and the warranty period shall commence.

## 1.6 QUALITY ASSURANCE

Materials shall be new and shall be the best of their respective kinds. All work shall be accomplished in a workmanlike manner in keeping with the best practices and highest standards of the telecommunications industry.

Protect materials and equipment from physical or environmental damage during shipping, storage and installation. Equipment and materials shall be received at the site in new condition and shall be maintained in new condition throughout the installation process. Damaged or deteriorated equipment and materials will not be acceptable. The Contractor shall be responsible for the safety and condition of all materials and equipment, whether stored or installed, until Final Acceptance by the Engineer and the Owner.

## 1.7 CODES AND STANDARDS

All work done under this contract shall be performed in accordance with the most recent issue of the following codes, standards and guidelines. Where there is a perceived conflict between a standard or guideline and the contract documents, the Contractor shall perform the work as directed by the Engineer.

| | |
|---|---|
| NFPA 70 | National Electric Code - 2020 Edition |
| NFPA 90A | Standard for the installation of Air-Conditioning and Ventilating Systems – 2021 edition |
| NFPA 101 | Life Safety Code - 2021 Edition |
| FBC | Florida Building Code – 2023 8th Edition<br>Florida Fire Prevention Code – 2023 8th Edition<br>Florida Building Code Accessibility – 2023 8th Edition |
| TIA | Telecommunications Industry Association, current edition of each standard at the time of bids applies (regardless of edition indicated below) |
| TIA-568.0-E | Generic Telecommunications Cabling for Customer Premises |

| | |
|---|---|
| TIA-568.1-E | Commercial Building Telecommunications Infrastructure Standard |
| TIA-568.2-E | Balanced Twisted-Pair Telecommunications Cabling and Components Standard |
| TIA-568.3-E | Optical Fiber Cabling and Components Standard |
| TIA-568.4-D | Broadband Coaxial Cabling and Components Standard |
| TIA-569-E | Telecommunications Pathways and Spaces |
| TIA-598-D | Optical Fiber Cable Color Coding |
| TIA-526-7-A | Standard Test Procedures for Fiber Optic Systems (Singlemode Fiber Optical Power Loss measurement TIA-526-7 Revision A 2015 and Multimode Fiber Optical Power Loss measurement TIA-526-14 Revision C 2015). |
| TIA-606-D | Administration Standard for Commercial Telecommunications Infrastructure |
| TIA-607-E | Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises |
| TIA-758-B | Customer-Owned Outside Plant Telecommunications Infrastructure Standard |
| TIA-862-C | Structured Cabling Infrastructure Standard for Intelligent Building Systems |
| IEEE | Institute of Electrical and Electronics Engineers |
| | IEEE 802-2001, IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture |
| IEEE | LAN/MAN Bridging & Management (802.1) |
| | IEEE 802.1f-1993, IEEE Standard for Local and Metropolitan Area Networks: Common Definitions and Procedures for IEEE 802 Management Information |
| | IEEE 802.1h, 1997 Edition (R2001) (ISO/IEC TR11802-5: 1997 ), IEEE Technical Report and Guidelines--Part 5: Media Access Control (MAC) Bridging of Ethernet V2.0 in Local Area Networks |
| | IEEE 802.1b, 1995 Edition (ISO/IEC 15802-2-1995), IEEE Standard for Information technology--Telecommunications and information exchange between systems--IEEE standard for local and metropolitan area networks--Common specifications--Part 2: LAN/MAN Management |

IEEE 802.1d, 1998 Edition (ISO/IEC 15802-3:1998, IEEE Standard for Information technology--Telecommunications and information exchange between systems--IEEE standard for local and metropolitan area networks--Common specifications--Media access control (MAC) Bridges

IEEE 802.1t-2001, Amendment to IEEE Std 802.1D, 1998 Edition IEEE Standard for Information technology--Telecommunications and information exchange between systems--Local and metropolitan area networks--Common specifications--Part 3: Media Access Control (MAC) Bridges: Technical and Editorial Corrections

IEEE 802.1w-2001, IEEE Standard for Information technology--Telecommunications and information exchange between systems--Local and metropolitan area networks--Common specifications Part 3: Media Access Control (MAC) Bridges--Amendment 2--Rapid Reconfiguration [Amendment to IEEE Std 802.1D, 1998 Edition (ISO/IEC 15802-3:1998) and IEEE Std 802.1t-2001]

IEEE 802.1e, 1994 Edition, IEEE Standard for Information technology--Telecommunications and information exchange between systems--IEEE standard for local and metropolitan area networks--Common specifications--Part 4: System Load Protocol

IEEE 802.1g, 1998 Edition, Information technology--Telecommunications and information exchange between systems--IEEE standard for local and metropolitan area networks--Common specifications--Part 5: Remote Media Access Control (MAC) bridging

IEEE 802.1q-1998, IEEE standard for local and metropolitan area networks: Virtual Bridged Local Area Networks

P802.1s/D13, Draft IEEE Standard for Local and Metropolitan Area Networks--Amendment 3 to IEEE 802.1q Virtual Bridged Local Area Networks: Multiple Spanning Trees

IEEE 802.1u-2001, (Amendment to IEEE Std 802.1q, 1998 Edition) IEEE Standard for Local and metropolitan area networks--Virtual Bridged Local Area Networks--Amendment 1: Technical and editorial corrections

IEEE 802.1v-2001, (Amendment to IEEE Std 802.1q, 1998 Edition) IEEE Standards Amendment to IEEE 802.1q: IEEE Standards for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks--Amendment 2: VLAN Classification by Protocol and Port

IEEE 802.1x2001 IEEE Standards for Local and Metropolitan Area Networks: Port-Based Network Access Control

IEEE CSMA/CD Access Method (802.3)

IEEE 802.3-2002® IEEE Standard for Information technology--Telecommunications and information exchange between systems-Local and metropolitan area networks--Specific requirements -Part 3:

Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications. Incorporates the IEEE 802.3z Standard for 1000BASE-X Gigabit Ethernet over fiber optic cabling and the IEEE 802.3ab Standard for 1000BASE-T Gigabit Ethernet over copper UTP cabling.

IEEE 802.3ae-2002 (standard ratified June 2002)
Supplement to IEEE 802.3 CSMA/CD Access Method & Physical Layer Specifications - Media Access Control (MAC) Parameters, Physical Layer, and Management Parameters for 10Gb/s Operation

IEEE 802.3at Amendment: Data Terminal Equipment (DTE) Power Via the Media Dependent Interface (MDI) Enhancements (PoE Plus)

IEEE — Wireless LANs (802.11)

IEEE Std 802.11, 1999 Edition, IEEE Standard for Information Technology - Telecommunications and Information Exchange between Systems - Local and Metropolitan Area Network - Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

IEEE 802.11a-1999, Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications—Amendment 1: High-speed Physical Layer in the 5 GHz band (An errata is available)

IEEE 802.11b-1999 Supplement to 802.11-1999,Wireless LAN MAC and PHY specifications: Higher speed Physical Layer (PHY) extension in the 2.4 GHz band

IEEE 802.11d-2001, Amendment to IEEE 802.11-1999, (ISO/IEC 8802-11) Information technology--Telecommunications and information exchange between systems--Local and metropolitan area networks--Specific requirements--Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications: Specification for Operation in Additional Regulatory Domains

IEEE 802.n-2009, Amendment 5 to IEEE 802.11-1999, Enhancements for Higher Throughput

IEEE 802.11ac, Enhancements for very high throughput WLANs

IEEE 802.11ax-2021 High Efficiency WLANs (WiFi-6)

BICSI — Building Industry Consulting Service International

Telecommunications Distribution Methods Manual (TDMM) Latest Edition

Network Design Reference Manual (NDRM) Latest Edition

Outside Plant Design Reference Manual (OSPDRM) – Latest Edition

Telecommunications Cabling Installation Manual (TCIM) Latest Edition

AT&T "Outside Plant Engineering Handbook"

All materials and equipment shall be UL listed for the intended application.

1.8 PRE-INSTALLATION SUBMITTALS

A. Manufacturer's Catalog Data:

Submit five (5) copies of manufacturer's standard descriptive data sheets to the Engineer for review and approval prior to commencing work. Furnish complete data sheets bearing the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the data sheets for the specific product being provided with an identifying mark, arrow, or highlighting. The following items shall be submitted:

1. Conduit and Pull Boxes, Fittings, Related Hardware & Accessories, each type
2. Handholes
3. Backboards (cabinet grade AC plywood)
4. Cable Runway, Fittings, Related Hardware & Accessories, each type
5. Racks, Related Hardware & Accessories, each type
6. Enclosures and Cabinets, each type
7. WAP mounts, each type
8. Copper Patch Panels, each type
9. Copper Wiring/Patch Blocks, each type
10. Category 6 UTP Cable , each type
11. Category 6A Cable, each type
12. Category 6 and 6A horizontal patch panels, frames and inserts, each type
13. Burial grade Category 6 and Category 6A cables
14. Patch Cables - Copper and Fiber Optic, each type
15. Patch Cord Organizers and Cable Rings, each type
16. Wire Management Devices, each type
17. Communications Outlets (CO), each type
18. Special Purpose Outlets, each type
19. Power Surge Protectors
20. Uninterruptible Power Supplies (UPS), each type
21. Grounding Busbars and Lugs, each type
22. Firestopping Systems, each type
23. Labeling Products, each type
24. All other materials and equipment indicated to be furnished under this section, whether specifically listed here or not.

B. Pre-Installation Drawings:

As part of the Structured Cabling System installation, the Contractor shall provide detailed documentation to facilitate system administration, maintenance, and future moves, adds and changes. Drawings shall be provided which incorporate all information in the Contract Drawings, and which fully document any and all Engineer approved changes in materials and methods made by the Contractor. Drawings are not required if no changes to the design are made by the Contractor. Changes to the design shall not be made without the

prior written approval of the Engineer. Drawings shall provide the same level of detail as the bid documents. *Electronic files of the Engineer's AutoCAD drawings will not be provided to the Contractor*.

Drawings shall be prepared using AutoCAD Release 14 and shall be furnished in hard-copy format and on industry standard CD or ZIP drive media.

Submit five (5) copies of pre-installation drawings to the Engineer for review and approval prior to commencing work.

1.9 CONTRACTOR'S RECORD DOCUMENTS

The Structured Cabling System Contractor shall maintain a full set of contract documents at the job site at all times, consisting of specifications, drawings, addenda, pre-installation submittals, change orders, and change directives. The record documents shall be updated by the Contractor, in red pen and on a daily basis, to show the following:

1. Final location of all Communications Outlets, Wireless Access Points, and security cameras.
2. Final conduit routing.
3. Location of all buried utilities encountered during the course of work on this project.
4. Final location of all handholes, pull boxes, and access doors.
5. Any changes to the work authorized by the Owner/Engineer.
6. Any other pertinent information that may be of value to the Owner in operating and maintaining the system.

The Contractor's record documents shall be available for viewing by the Engineer or the Owner at the site at any time and shall be presented and reviewed by the Contractor at each construction progress meeting. The record documents shall be clearly marked "Record Set", shall be kept in a protected location, and shall not be used for general construction purposes. The record documents shall be provided to the Engineer at the close of the project.

The Engineer will provide a full set of Adobe Acrobat *.PDF format drawings to the Contractor. The Contractor shall be required to annotate (redline) the Adobe Acrobat *.PDF format drawings using Adobe Acrobat to reflect all changes recorded in the field as required by the paragraph "CONTRACTOR'S RECORD DOCUMENTS". The Contractor shall provide a copy of the Adobe Acrobat *.PDF files on CD with each set of O&M Manuals and shall provide an additional copy on CD to the Engineer. The Contractor shall also provide 11"x17" laser prints of Adobe Acrobat *.PDF drawings in each O&M Manual.

PART 2 - PRODUCTS

2.1 GENERAL

All materials, equipment, and devices shall be new and unused, of current manufacture and of the highest grade, free from defects.

All products shall be the manufacturer and model or part number specified. Where a model or part number is indicated in error for any reason, the Contractor shall verify the intent of the Engineer prior to providing a proposal and shall provide the product intended by the Engineer. Where a manufacturer has updated or improved a product subsequent to

issuance of the bid documents by the Engineer, the Contractor shall provide the updated or improved product at no additional cost to the Owner.

Provide new equipment and materials only. Each component shall be the most recent model number, revision, or update offered by the manufacturer at the time of purchase by the Contractor. Newly manufactured containing used or rebuilt parts, remanufactured, rebuilt, reconditioned, used, shopworn, demonstrator or prototype equipment is not acceptable and will be rejected. Each major component of telephone and data systems equipment provided under this contract shall include a certification from the manufacturer stating that the equipment is new and referencing the serial number of the delivered equipment. The Contractor shall track the placement of each major component in the field and shall provide the Owner a list identifying each component by manufacturer, model number, serial number, and installed location (example rack number and rack position).

All materials, equipment and devices shall meet the requirements of UL where UL standards are established for those items, and the requirements of NFPA 70.

All like items of material or equipment shall be the same product of the same manufacturer, model number and production series.

All materials and equipment shall be a standard catalogued product of a manufacturer regularly engaged in the manufacture of similar products.

## 2.2 PRODUCT SPECIFICATIONS

See drawings for all product requirements not indicated in these specifications. The Structured Cabling Contractor shall be responsible for providing and installing all components indicated in these specifications and on the drawings, unless specifically indicated to be provided by others.

A. Structured Cabling System:

Provide all system components as indicated the drawings. To ensure a uniform basis for bidding, and to standardize the Owner’s facilities, base all bids on the particular systems, equipment and materials specified.

B. Data and Wireless Systems:

See drawings for data cabling system specifications and equipment mounting requirements.

Data equipment and wireless LAN equipment shall be Owner Furnished Contractor Installed (OFCI) as indicated on the drawings, unless specifically indicated otherwise.

Provide a system of data cabling as indicated on the drawings, to include wiring for Wireless Access Points, security camera systems and network interfaces to other systems as indicated on the drawings.

Wireless Access Points:

The Contractor shall install new WAPs furnished by the Owner at WAP locations indicated on the drawings and finalized by the Owner. WAPs shall be Owner Furnished Contractor

Installed (OFCI) as indicated on the drawings. WAP mounts shall be Contractor Furnished Contractor Installed (CFCI).

The Structured Cabling System Contractor shall provide two Category 6A cables to each and WAP location in support of Owner furnished equipment. Direct terminate and test, coil slack in ceiling cavity at each WAP and at the Communications Closet.

C. Telephone System:

The Owner will provide VOIP equipment, handsets and all programming and system setup.

## PART 3 - EXECUTION

### 3.1 GENERAL

The installation shall be in strict accordance with all applicable codes and standards, the respective manufacturer's written recommendations, and the contract drawings and these specifications.

Workmanship shall be of the highest grade in accordance with the best modern practice and the highest standards of the telecommunications industry.

The installed system shall be neat, clean, and well organized in appearance. Provide working clearances for normal system operation, reconfiguration and repair.

The completed installation shall meet with the approval of the Owner’s Project Manager and the Engineer.

The General Contractor and the Structured Cabling System Contractor (SCSC) shall share full responsibility for protecting all communications outlets, the CC and all structured cabling system components from dust and debris during construction and until final completion of the project. The SCSC shall not install racks, wire managers, patch panels, protector blocks, 66 blocks, or dress out and terminate cables until paint, backboards and floors in the CC are completely finished and those rooms are completely isolated from dust infiltration with plastic sheeting and duct tape. All COs jacks shall be protected by bagging and sealing dust tight at all times after connectivity devices are installed. All system components that, in the sole judgment of the Engineer, are exposed to excessive accumulation of construction dust/debris at any stage of the project shall be removed and replaced with new components at no additional cost to the Owner. Lay-in ceiling grids in the CC shall be installed after conduits and cable trays and cable runways have been installed to allow the ceiling installer to trim around conduits. Lay-in ceiling tiles in these areas should follow completion of cable dressing into racks.

The SCSC shall not install racks, wire managers, patch panels, protector blocks, 66 blocks, or dress out and terminate cables until paint, backboards and floors in the CC are completely finished and those rooms are completely isolated from dust infiltration with plastic sheeting and duct tape.

A. Delivery:

Protect materials and equipment from physical or environmental damage during shipping,

storage and installation. Equipment and materials shall be received at the site in new condition in original factory sealed cartons and shall be maintained in new condition throughout the installation process. Damaged or deteriorated equipment and materials will not be acceptable. The Contractor shall be responsible for receiving and storing of all equipment and materials and shall be responsible for the safety and condition of all materials and equipment, whether stored or installed, until Final Acceptance by the Engineer and the Owner.

B. Data Equipment:

See drawings for data cabling system specifications. Provide a system of data cabling as indicated on the drawings, to include wiring for Wireless Access Points, security camera systems and network interfaces to other systems as indicated on the drawings.

Data equipment and wireless LAN equipment shall be Owner Furnished Contractor Installed (OFCI) as indicated on the drawings, unless specifically indicated otherwise.

Wireless Access Points:

The Contractor shall install new WAPs furnished by the Owner at WAP locations indicated on the drawings and finalized by the Owner. WAPs shall be Owner Furnished Contractor Installed (OFCI) as indicated on the drawings. WAP mounts shall be Contractor Furnished Contractor Installed (CFCI).

The Structured Cabling System Contractor shall provide two Category 6A cables to each and WAP location in support of Owner furnished equipment. Direct terminate and test, coil slack in ceiling cavity at each WAP and at the Communications Closet.

Power Cords: The Structured Cabling System Contractor shall route Owner furnished power cords connecting all Owner Furnished data equipment to rack power strips or uninterruptible power supplies as indicated on the drawings. Cords shall route from equipment, up or down on racks attached to standoff brackets as indicated on drawings, and over to rack power strips or UPS connections. Properly routed and secure at 12 inches on center, with only one cord allowed per connection, and neatly coiling excess cord length and securing coil with black velcro.

Coordinate all related work with the Owner's Project Manager and District IT staff.

C. Telephone System:

The Owner will provide a VOIP based telephone system with handsets (OFOI).

Provide and install patch cords from VOIP connections to horizontal wiring connections as specified herein and as indicated on the drawings.

See drawings for specific requirements.

Coordinate all work with the Owner and the telephone service provider.

F. Conduit Installation:

All conduit shall be installed by a licensed electrical contractor using tradesmen who are

skilled and experienced in the types of conduit installations indicated in the bid documents.

All backbone cabling shall be run continuously in conduit.

The following horizontal cabling, along with any other cabling so indicated on the drawings shall be run continuously in conduit:

1. All Category 6 cabling for special circuits shall be run continuously in conduit.
2. All Category 6 and 6A cabling run in exposed structure spaces without ceilings limited to mechanical equipment rooms, electrical equipment rooms and storage rooms with no ceilings, shall be installed continuously in conduits extended to accessible lay-in ceiling areas at each end.
3. All Category 6 and 6A cabling run above hard ceilings shall be installed continuously in conduits extended to accessible lay-in ceiling areas at each end.
4. Where specifically indicated elsewhere horizontal cabling shall be installed continuously in conduit.

Do not pull cables in conduits until plastic insulating bushings have been installed. Cables installed in conduits without plastic insulating bushings shall be removed and replaced with new cables.

Rack conduits and run together wherever possible.

Conduit shall be installed with top-grade workmanship, using factory bends or field bends made with the proper tools. Kinked, dented or otherwise improperly constructed bends will not be accepted. All bends shall have a minimum radius of six times the internal conduit diameter.

All conduit shall be routed parallel and perpendicular to building lines, up high and over piping, ductwork, conduit and other utilities. Conduit in exposed locations shall be run as high as possible, secured with heavy duty galvanized two-hole supports, and otherwise installed to prevent damage from pulling, hanging, etc.

Install plastic insulating bushings on the ends of all conduits prior to installing cables. Provide conduit end fitting with threaded end and threaded plastic insulating bushing on all EMT conduit ends. Provide UL listed threaded malleable iron insulated grounding bushing on all IMC or RMC conduit ends – add on grounding clamps will not be accepted. Cables installed without plastic insulated bushings or insulated grounding bushings in place shall be removed, the proper bushings installed, then the cables reinstalled, terminated and tested – no exceptions will be made to these requirements.

Firestop all conduit penetrations of all aboveground floors, all conduit penetrations of walls that extend to the underside of the floor or roof deck above, and all conduit penetrations of all walls indicated as fire rated on the architectural drawings. Accomplish firestopping using UL classified systems with fire rating equal to or greater than the fire rating of the floor or wall assembly penetrated. Firestop systems shall be 3M, Nelson or Engineer approved equal. Install in strict accordance with the manufacturer's printed instructions and the conditions of the UL approval for each firestop system used.

All conduit penetrations of walls indicated as smoke walls on the architectural drawings and all conduit penetrations of walls that do not extend to the underside of the floor or roof deck above shall be sealed smoketight and acoustically with smoke-sound caulking UL listed for the purpose such as USG Firecode, STI Smoke ‘N’ Sound, or Hilti CP 506.

All buried conduit shall be Schedule 80 electrical grade PVC conduit. All PVC conduit joints shall be cleaned and glued for a watertight connection. Terminate ends of PVC conduit at closets and handholes with end bells.

Seal all underground conduits at handholes and at building entry points following cable installation to prevent the entry of water into buildings, and to prevent the entry of water or debris into the conduits from the handhole or building side. Sealant shall be POLYWATER FST-250 and shall be installed using factory caulking tube, mixing nozzle, damming strips (all included in FST-250KIT1) package.

Buried warning and identification tape: Provide metallic detection tape manufactured specifically for warning and identification of buried utilities. Install tape directly above each buried conduit at depth of 10 to 12 inches below grade for entire length of conduit. Tape shall be detectable by any standard Non-Ferric Metal Detector. Provide tape in rolls, 2 inches minimum width, color orange, with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall read "CAUTION BURIED COMMUNICATIONS LINE BELOW". Use permanent code and letter coloring unaffected by moisture and other substances contained in backfill material.

Underground Conduit Validation:

Following installation of underground conduits, perform the following operation for each conduit:

Clean, lubricate and validate each installed conduit for serviceability by running a full size rubber duct swab through the conduit from end to end. Conduits that are obstructed may be cleaned using a wire brush mandrel, then revalidated with the full size rubber duct swab. Conduits that do not allow passage of the full size rubber duct swab shall be replaced.

Pull Tapes: As backbone cabling runs are installed, provide a continuous marked pull tape (Carlon TL3821800 lb. tensile strength) for the full length of the end-to-end cable run with 10 feet of slack at each end pulled in alongside cabling. Bundle slack neatly at each end and tie off to conduit support strut at each end. Provide continuous factory uncut lengths of pull tape from end-to-end - under no circumstances shall pull partial length section of pull tape be tied together.

Spare Conduits: For conduits that are indicated as spare, install a continuous marked pull tape (Carlon TL382 1800 lb. tensile strength) for the full length of the end-to-end conduit run with 10 feet of slack at each end, tie each end of the tape to a blank duct plug with rope tie tab, push slack tape back into conduit, and install a duct plug in each conduit end for a watertight seal.

G. Cabling Installation:

Do not pull cables in conduits until plastic insulating bushings have been installed. Cables installed in conduits without plastic insulating bushings shall be removed and replaced with new cables.

Cabling free-routed above ceiling: Category 6 and Category 6A cabling otherwise allowed to be free-routed shall be free-routed only where concealed above lay-in ceilings only for those applications not identified to run continuously in conduit. Install horizontal cabling shown to be free-routed parallel and perpendicular to building lines, up high and over piping, ductwork, conduit and other utilities, and in protected locations. All cabling shall be neatly and symmetrically bundled (maximum individual bundle size shall be as indicated on the

drawings), bound with Velcro wraps at a minimum of four feet on center, properly supported, and otherwise installed as indicated on the drawings. Provide plenum rated color black Velcro for Category 6 cables and plenum rated color cranberry Velcro for Category 6A cables outside of the Communications Closet. Within the CC provide non-plenum rated Velcro, color to match horizontal cable jacket colors and patch cord colors. Support all free-routed horizontal cabling bundles individually with Category 5 J-hooks (Erico "CABLCAT") at a minimum of four feet on center. Attach J-hooks to building structural members only using factory support system components. Secure cables bundles within J-hooks with factory contact free containment cable ties. Do not attach J-hooks to ceiling grids, ceiling supports, piping, ductwork, conduit or anything other than building structural members unless specifically approved by the Engineer. Do not support free-routed horizontal cabling by running over or directly attaching to building structural members, piping, ductwork, conduit or any other utility. Always bundle Category 6 and Category 6A cables separately. A maximum of 24 cables shall be included in each cable bundle, regardless of cable type.

Conduit sleeves for free-routed horizontal CAT 6 and CAT 6A: Final routing paths for free-routed horizontal cabling shall be determined by the contractor in the field. For this reason conduit sleeves are not indicated on the drawings. The contractor shall provide EMT conduit sleeves in the quantities and locations required to suit the contractor selected horizontal cable routing and as required for a complete installation, regardless of whether those sleeves are indicated on the drawings or not, and at no additional cost to the Owner. At locations where horizontal cabling runs through mechanical or electrical equipment rooms, the riser room, or storage rooms with exposed structure ceiling, all such cabling shall be run in continuous conduit sleeves extending to the nearest accessible lay-in ceiling at both ends. In addition, the contractor shall provide conduit sleeves traversing inaccessible (hard) ceiling or soffit areas and extending to the nearest accessible lay-in ceiling at both ends for cable pass-thru - provide access panels in inaccessible ceilings as required to install sleeves. Sleeves shall be sized for maximum 30 percent cable fill and shall be constructed and provided with pull boxes and access doors per the general aboveground conduit notes on the drawings.

Provide wire management devices on backboards and racks as indicated and as required to facilitate organized routing of cables and patch cords. Bundle cables together behind racks and fan out to points of termination. The finished installation shall meet the approval of the Engineer for overall quality and neatness of appearance.

The Contractor, in providing a bid for the system in accordance with the contract documents, agrees to install all cabling in the conduit and wireway paths indicated in the contract documents, or to provide larger conduit and wireway paths as he deems necessary, at no additional cost to the Owner. The Contractor shall be fully responsible for any and all damage to cabling that may occur during the installation and shall replace any damaged cabling with new cabling of the type specified for the application.

Firestop all cable penetrations of all aboveground floors, all cable penetrations of walls that extend to the underside of the floor or roof deck above, and all cable penetrations of all walls indicated as fire rated on the architectural drawings. Accomplish firestopping using UL classified systems with fire rating equal to or greater than the fire rating of the floor or wall assembly penetrated. Firestop systems shall be 3M, Nelson or Engineer approved equal. Install in strict accordance with the manufacturer's printed instructions and the conditions of the UL approval for each firestop system used.

All cable penetrations of walls indicated as smoke walls on the architectural drawings and all cable penetrations of walls that do not extend to the underside of the floor or roof deck above shall be sealed smoketight and acoustically with smoke-sound caulking UL listed for the

purpose such as USG Firecode, STI Smoke 'N' Sound, or Hilti CP 506.

H. Identification and Labeling:

The Structured Cabling System Contractor shall purchase and use professional labeling software and labeling products to generate all labels for this project, with the exception of engraved plastic tags and laminated paper tags, which shall be fabricated as indicated on the drawings, and elsewhere as indicated below. The Contractor shall determine the proper labeling product for each application and include a list of each product and application with the Pre-Installation Submittals.

All labels shall be produced using a laser printer and shall be clear and easily readable. Minimum text size shall be 12 point. Text font shall be ARIAL or ARIAL NARROW. Handwritten labels are not acceptable.

Label each horizontal cable and backbone cable using self-adhesive self-laminating polyester wrap-around labels with laser printed text as follows:

Label each Horizontal Category 6 and Category 6A cable cable at each end. Label text shall be based on the nomenclature indicated on the drawings.

Label each Fiber Optic Backbone Cable at each end. Label text shall be based on the nomenclature indicated on the drawings.

Label each Communications Outlet using non-adhesive card labels with laser printed text. Insert labels under outlet manufacturer's plastic label covers centered and straight. Label text shall be based on the Communication Outlet Identification Nomenclature and labeling details indicated on the drawings.

Label each Category 6 and Category 6A Horizontal Patch Panel port using non-adhesive or self-adhesive labels with laser printed text. The Contractor shall first attach the adhesive labels to the perforated paper labels supplied by the patch panel manufacturer, then insert the paper labels into the plastic covered icon-label holders supplied by the patch panel manufacturer. Label text for each patch panel port shall be based on the Horizontal Patch Panel Labeling Nomenclature and labeling details indicated on the drawings.

Label each Backbone Fiber Optic Cable Drawer with 1" high bold text printed on clear self- adhesive paper and attached to the reverse side of drawer manufacturer's paper label. Label text shall be based on the 'Fiber Optic Backbone Cable Nomenclature' indicated on the drawings to indicate source (CER) and each destination (respective CC or CP).

Label each Communications Panel, Rack and other devices as indicated on the drawings.

Provide data sheets describing all proposed labeling products with Pre-installation Submittals.

3.2 CABLE TESTING

A. General:

Prior to installation of cabling, visually inspect all cables, cable reels, and shipping

cartons to detect possible cable damage incurred during shipping and transport. Return visibly damages goods to the supplier and replace with new.

If post-manufacture performance data has been supplied by the manufacturer of cables or connecting hardware, copies of such data are to be kept for inclusion in the Documentation and made available to the Owner upon request.

After cabling installation and labeling is complete, but prior to the installation of patch cords, the Contractor shall test all cables. As part of cable test procedures verify all labeling and correct all inaccurate labeling.

The Contactor shall be in responsible charge of all cable testing procedures and shall provide an original signed letter in each project Operation & Maintenance (O&M) manual certifying that all cables have been tested in compliance with the contract documents and have met or exceeded the requirements stated therein.

Tests shall be performed in strict accordance with the test instrument manufacturer's printed instructions.

One hundred percent of all cables shall be tested.

Technicians performing testing shall be thoroughly trained in the use of the test instruments employed. Factory certification of technicians is mandatory. The Contractor shall provide evidence of training and copies of certificates to the Engineer.

The Contractor is responsible for supplying all test equipment and related materials required to test the entire Structured Cabling System. Test instruments shall be calibrated and traceable to the National Institute of Standards (NIST). Test instruments shall have been recently calibrated. The Contractor shall provide evidence of test instrument calibration if requested by the Engineer.

The requirement for this project is full compliance/zero tolerance. Cables that do not comply with the stated standards shall be removed and replaced with new. Partial use of cables by claiming good pairs or strands and abandoning others is not allowable. Defective cables shall be removed and replaced with new.

Notify the Owner in writing not less than five days prior to commencing cable testing. The Owner may elect to be present for and witness cable testing.

The Contractor shall be required to retest installed cables in the Owner's presence to verify the Contractor's test documentation. The percentage of cables to be retested shall be determined by the Owner based on compliance of the installation with the contract documents, quality of workmanship, and results of initial cable tests. Retesting shall be performed as required until all cables, in the judgment of the Owner, comply with the requirements of the contract documents.

B. Cable Test Results:

All cable test results shall be provided as part of the project Installation and Maintenance (O&M) Manuals.

C. Category 6 UTP Cable

Testing: Testers:

Each Category 6 cable shall be tested with Fluke Networks DSP-4300 Digital Cable Analyzers utilizing Fluke Networks DSP-LIA101 Universal Permanent Link Interface Adapters and the appropriate Personality Modules. In addition, each tester shall be calibrated prior to commencing testing for this project using a Fluke Networks DSP-PLCAL Universal Permanent Link Calibration Kit and Fluke Networks 'Linkware' software.

Prior to testing, electronically update tester software using the tester manufacturer's 'Linkware' software update utility. Update to the software version current at time tests are performed. Under no circumstances shall a tester with outdated software be used.

General:

Testing shall be of the Permanent Link. However, the Structured Cabling System Contractor and the Structured Cabling System Manufacturer shall warrant performance based on Channel performance and provide shall patch cords that meet Channel performance requirements.

All test results shall be maintained in the native file format of the tester manufacturer's 'Linkware' software. Under no circumstances shall be data be modified by other software, edited in any manner, or exported to a database, spreadsheet, work processor program or any other type of program that would allow access to the data for modification. Hardcopy printouts of test reports in Summary Format shall be generated directly from the 'Linkware' software. Detailed test results in Text Format shall be provided to the Owner in native 'Linkware' data format on a CD. In addition, detailed test results in Text Format shall be provided to the Owner in Adobe Acrobat *.PDF format on a CD. CDs shall be included in the project Operation and Maintenance (O&M) manuals.

Record all test conditions and setup parameters and include in a typed discussion to be provided with test documentation.

*Verify correct labeling of patch panels and communications outlets prior to and during testing. If any label is found to be in error, correct before proceeding with testing. Circuit Identification (cable I.D.) in cable test reports shall be exactly the same as the outlet labeling based on the nomenclature indicated on the drawings.*

Testing:

After installation, termination and labeling of the Category 6 UTP cable is complete and approved by the Structured Cabling System Contractor's RCDD, test each cable in accordance with all applicable TIA/EIA standards for UTP Category 6, and complete all operations required for a Panduit Certified Cabling System and 25 year Belden System Warranty.

Prior to testing, electronically update tester software using the tester manufacturer's 'Linkware' software update utility. Update to the software version current at time tests are performed. Under no circumstances shall a tester with outdated software

be used.

Test each cable to verify compliance with TIA/EIA specifications for Category 6 UTP, Permanent Link configuration, Level III accuracy, with no allowable deviation. Test at the full range of frequencies indicated by TIA/EIA up to and including 250 MHz.

Test using the tester manufacturer's standard TIA/EIA Category 6 Autotest. Under no circumstances shall a Custom Cable Autotest designed by the tester manufacturer specifically for a given cable manufacturer or structured cabling system manufacturer be used to test cables. All tests and testing procedures for this project shall be strictly based on TIA/EIA standards. Enter the proper Nominal Velocity of Propagation (NVP) for the specific cable(s) installed. Test for the following parameters:

1. Wire Map – verify no shorts, opens, miswires, split, reversed or crossed pairs, and end-to- end connectivity is achieved.
2. Cable Length
3. Insertion Loss (attenuation)
4. NEXT Loss
5. PSNEXT Loss
6. ELFEXT Loss
7. PSELFEXT Loss
8. Return Loss
9. ACR
10. PSACR
11. Propagation Delay
12. Delay Skew

Documentation:

Test documentation for Category 6 cabling shall include the following:

1. An introductory discussion documenting each test instrument used, the Autotest routine used on each test instrument, qualifications of operators, test conditions, setup parameters, and any other pertinent information.

2. A summary hardcopy printout for all cables using the tester manufacturer's standard 'Linkware' software to produce an "AutoTest Summary" report. The summary report shall include Project Name, Circuit I.D., Result (pass or fail) and the cable length. The report shall be printed directly out of the 'Linkware' program in native format and in *.PDF format – under no circumstances shall the data be exported to any other type of program at any time.

3. A full-page text only detailed test result for each cable using the tester manufacturer's standard 'Linkware' software to produce an "AutoTest Report". Each report shall be printed directly out of the 'Linkware' program in native format and in *.PDF format
   - under no circumstances shall the data be exported to any other type of program at any time. Each report shall include the following components:

   - Tester manufacturer, model, serial number, hardware version, and software version
   - Project Name
   - Operator Name

- Cable manufacturer, cable part number/type and NVP
- Circuit I.D.
- Autotest specification used (must be standard TIA Category 6 autotest)
- Identification of the tester interface used
- Overall pass/fail indication
- Date of Test
- Wire Map
- Cable Length in feet
- Insertion Loss (attenuation)
- NEXT Loss*
- PSNEXT Loss*
- ELFEXT Loss*
- PSELFEXT Loss*
- Return Loss*
- ACR*
- PSACR*
- Propagation Delay
- Delay Skew

* Measure from both ends of each cable

4. A PASS or FAIL result for each parameter shall be determined by comparing the measured values with the specified test limits for that parameter. The test result for each parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer shall provide documentation as an aid to interpret results marked with asterisks.

   Each individual test that fails the relevant performance specifications shall be marked as FAIL or FAIL*. Any FAIL or FAIL* result yields a FAIL rating for the link-under-test. In order to achieve an overall PASS rating, the results for each individual test parameter must yield a PASS or PASS* result.

5. Cable identities (Circuit IDs) shall be based on the labeling nomenclature described on the drawings.

6. Transfer of Software to Owner: Provide tester manufacturer's 'Linkware' software, latest version, to the Owner for the Owner's use in viewing and managing test results.

7. Provide all Category 6 cable test documentation in the project O&M Manuals. Category 6 Cable Performance Criteria:

   If the test results for any cables, in the sole judgment of the Engineer, fail to confirm acceptable performance, the Contractor shall reconnectorize or replace with new the affected cables as required to achieve specified performance levels as demonstrated by retesting.

D. Category 6A UTP

Cable

The Structured Cabling System Contractor shall provide a Category 6A tester and shall test all Category 6A cabling for the Permanent Link in strict accordance with TIA standards for Category 6A testing and characterized to 500 MHz. The contractor shall

provide a full test report equivalent in scope to the report required above for Category 6 cabling.

The final test report shall indicate that each Category 6A cable achieved a PASS rating without exception.

If the test results for any cables, in the sole judgment of the Engineer, fail to confirm acceptable performance, the Contractor shall reconnectorize or replace with new the affected cables as required to achieve specified performance levels as demonstrated by retesting.

E. Fiber Optic Cable

Testing: General:

Clean all fiber optic connectors, sleeves and test cords prior to testing. Follow all other recommendations of the test instrument manufacturer for cable and instrument preparation.

Record all test conditions and setup parameters and include in a typed discussion to be provided with test documentation.

On-the-Reel-Testing:

Before commencing the installation and with the cable on the reel, test at least one fiber strand on each cable reel to verify that the cable is undamaged. Record and print test results for future reference.

Post-Installation Testing:

Multimode and Singlemode fiber optic cable end face testing:

Test all fiber end faces using Fluke Networks FI-7000 FiberInspector Pro for automated Pass/Fail certification of fiber optic connector end-faces and graphical indication of problem areas due to contamination, pits, chips, and scratches. The contractor shall save all fiber optic connector end-face views during the certification process for viewing upon request of the Owner until the entire installation is approved by the Owner. All end faces shall Pass certification.

Multimode Fiber Optic Cable Testing:
After installation, termination and labeling of fiber optic cable is complete and approved by the Structured Cabling System Contractor's BICSI Certified Technician, test each strand of fiber to verify that the installed cable meets the performance requirements described below. Test in accordance with the current edition of TIA/EIA-568-B with the additional (and more stringent) requirements following:

Test fiber using the Fluke Networks DSP-4300 Digital Cable Analyzer specified for Category 6 UTP cable in combination with a Fluke Networks DSP-FTA440 Gigabit Multimode Fiber Test Adapters. The DSP-FTA440 Fiber Test Adapter uses a VCSEL source at 850nm and a FP Laser light source at 1310nm for testing multimode fiber running Gigabit Ethernet. Test as follows:

1. Test two fiber links at the two specified wavelengths simultaneously. Perform bi-directional testing on both strands of the fibers-under-test and save results in one record.
2. Measure length for each cable link.
3. Measure attenuation for each cable link.
4. Utilize Fluke Networks 'Linkware' software to store test results and to generate reports.

Test results shall include all test parameters including length and attenuation at each wavelength for each fiber link (terminated strand). Attenuation shall be the worst case result yielded from bi-directional testing. All test results shall be maintained in the native file format of the tester manufacturer's 'Linkware' software. Under no circumstances shall be data be modified by other software, edited in any manner, or exported to a database, spreadsheet, work processor program or any other type of program that would allow access to the data for modification. Detailed test results in Text Format shall be provided to the Owner in native 'Linkware' data format. In addition, detailed test results in Text Format shall be provided to the Owner in Adobe Acrobat *.PDF format. Test results shall be included in the project Operation and Maintenance (O&M) manuals.

Insert all fiber optic cable test documentation in the project O&M manuals.

Fiber Optic Cable Performance Requirements:

Each link of the installed fiber optic cabling, with mated connectors at each end, shall have a total attenuation (in db) less than or equal to the manufacturers' performance specifications for the cable and connectors called for in the contract documents, with the cable attenuation adjusted for the installed length, and with an allowable deviation of +1.0 db. If the test results for a given strand or strands, in the sole judgment of the Engineer, indicate excessive attenuation based on these requirements, the Contractor shall repolish, reconnectorize, or replace the affected cables as required to achieve the specified performance levels as demonstrated by retesting.

The Contractor should note that these specifications are more stringent than the TIA/EIA-568-B criteria for either horizontal or backbone fiber lengths in terms of allowable link attenuation and plan the installation accordingly.

Singlemode Fiber Optic Cable Testing:

Singlemode fiber optic cable testing shall follow the same general requirements as described for multimode fiber but shall be tested using two methods. Test in accordance with the current edition of TIA-526-7-A with the additional (and more stringent) requirements following:

Test using a Fluke Networks DSP-4300 Digital Cable Analyzer in combination with a Fluke Networks DSP-FTA430 Singlemode Fiber Test Adapter. Secondly test using an OTDR in strict accordance with associated TIA standards. Graphical test results shall be provided showing the entire OTDR trace to include the launch cord and terminations at each end shall be provided. Each strand of the installed fiber optic cabling, with mated connectors at each end, shall have a total attenuation (in db) less than or equal to the manufacturers' performance specifications for the cable and connectors called for in the contract documents,

with the cable attenuation adjusted for the installed length, and with an allowable deviation of +1.0 db. If the test results for a given strand or strands, in the sole judgment of the Engineer, indicate excessive attenuation based on these requirements, the Contractor shall repolish, reconnectorize, or replace the affected cables as required to achieve the specified performance levels as demonstrated by retesting.

3.3 Patch Cord Installation:

Prior to Equipment Verification, the contractor shall install patch cords in a neat and workmanlike manner using the wire management devices indicated on the drawings. The contractor shall work side by side with the Owner's IT Staff throughout the entire patch cord installation for purposes of coordination and training.

Prior to installation of patch cords, the contractor shall account for all patch cords in the presence of the Owner's Project Manager and the Owner's IT Staff and shall present to the Project Manager a typed inventory of the patch cords broken down by type and length as scheduled on the drawings. The Owner's Project Manager will verify patch cord types, quantities, and lengths and will sign the inventory indicating that the contractor has delivered patch cords to the job site in accordance with the requirements of the contract documents. The contractor shall provide a copy of the inventory, signed by the Owner's Project Manager, in the O&M Manuals.

The signature of the Owner's Project Manager does not indicate acceptance of ownership of the patch cords by the Owner. Ownership of patch cords shall be transferred to the Owner at the same time as the project as a whole.

Following verification of patch cords types, quantities and lengths by the Owner's Project Manager, the contractor shall complete the patch cord installations as follows:

A. Data and VOIP Copper Patch Cords – CER and CC:

Install data patch cords connecting each port of all data equipment from data equipment connections to horizontal patch panels. Horizontal wiring connections to be made active shall be as directed by the Owner's Project Manager and the Owner's IT Staff in the field.

*Provide a typed cross-reference list in Microsoft Excel spreadsheet format identifying data equipment ports and corresponding horizontal wiring connections – place hardcopy and CD of spreadsheet in three ring binder and mount binder on the backboard adjacent to the racks. Provide additional hardcopy and CD in O&M Manuals. Email copy of Excel Spreadsheet to the Engineer and the Owner's Project Manager.*

Patch cords shall be neatly routed and bundled with black velcro at 6 inches on center in wire management devices from connection to connection. Patch cord lengths shall be selected by the Contractor from the stock supplied under the project to provide a neat installation in the racks and wire management systems without excess length. Note - Bundle data patch cords together – do not mix data patch cord bundles with voice patch cord bundles or fiber optic patch cord bundles. The entire installation shall require the site approval of the Engineer.

B. Fiber Patch Cords – CER and CC:

Install fiber optic patch cords to connect all data equipment fiber optic ports as directed by

the Owner's Project Manager and IT Staff in the field. Patch cords shall be neatly routed and bundled with black velcro at 3 inches on center in wire management devices from connection to connection. Patch cord lengths shall be selected by the Contractor from the stock supplied under the project to provide a neat installation in the racks and wire management systems without excess length. Note - bundle fiber optic patch cords together – do not mix fiber optic patch cord bundles with data patch cord bundles or voice patch cord bundles. The entire installation shall require the site approval of the Engineer.

C. Workstation Patch Cords

The Contractor shall, in coordination with the Owner's Project Manager and IT Staff, install workstation data patch cords in the locations designated by the IT Staff as described above for connection of equipment room data patch cords to horizontal wiring connections. In addition, the Contractor shall work side by side with the Telephone System Provider to install telephone line cords as telephone instruments are set.

## 3.4 EQUIPMENT VERIFICATION

After installation of patch cords and before System Startup, the Contractor shall assist the Owner to power-up all data equipment and verify proper operation. The Contractor shall coordinate with the Owner to verify all cable interfaces are working and operational with the equipment. The contractor shall make any cabling system changes and additions as necessary and/or provide patch cables as required to complete the installation.

## 3.5 FINAL CLEANUP

Prior to the Substantial Completion Inspection, perform final cleanup of all work and all areas in which work was performed. All work areas shall be left vacuum clean. All raceway, faceplates, jack assemblies, racks, panels, data equipment, and the like shall be thoroughly wiped down to remove small amounts of dust accumulated during the course of the project. Jacks, patch panels, wiring blocks and data and voice equipment shall be cleaned with a high powered vacuum cleaner to completely remove internal dust. All painted surfaces such as backboards shall be touched up with paint to remove scuff marks, pencil marks, scratches, etc. All factory surfaces shall be touched with matching paint obtained by the Contractor from the factory.

## 3.6 CLOSE-OUT DOCUMENTATION

A. Operation & Maintenance Manuals:

Provide O&M Manuals as required by the architectural specifications and as follows.

The O&M Manuals shall contain sufficient information to permit Owner personnel to operate the system with or without assistance from the Contractor.

The Contractor shall provide O&M Manuals covering all equipment and materials furnished under this contract. The O&M Manuals shall contain all information necessary for the operation, maintenance, parts procurement, and parts replacement for the structured cabling system. The information shall include detailed documentation for firmware configuration.

Quantity: Three (3).

Format: *Provide 8-1/2" x 11" loose-leaf 3-ring binders with clear vinyl overlay designed to receive identification inserts. 3-ring binders shall be heavy- duty D-Ring type, over-sized to allow the insertion of additional system documentation in the future.*

Project Identification: Furnish project identification *inserted under the clear vinyl overlay on the front cover and the back spline as follows:*

Operating & Maintenance Manual
Project Name
Structured Cabling System Contractor

Project Information: On the front page, *enclosed in a 3-ring clear plastic sheet protector*, provide the following information:

Project Name
Structured Cabling System Contractor
Name Structured Cabling System
Manufacturer Name Electrical Contractor
Name
Contractor's Project Manager
Contact list with name, address, contact person, and phone number for each of the following:

Structured Cabling System
Contractor Structured Cabling
System Manufacturer Electrical
Contractor

Index: On the second page, *enclosed in a 3-ring clear plastic sheet protector*, provide an index indicating the following section numbers and titles.

Sections: All sections shall be separated with an appropriate tabbed section divider with the appropriate number and title (typed) as follows:

Section 1 – Cuts Sheets:

Manufacturer's original data/cut sheets for each system component. Section 2 – Data Equipment List:
Typed list of each item of data equipment (including Owner furnished data equipment) with brief description, serial number, and part number. Note where each item of equipment is installed (CER/CC number, rack number and mounting position in rack). *Enclose in a 3-ring clear plastic sheet protector.*

Section 3 – Factory Manuals:

Manufacturer's printed Installation and Operating Manuals for each item of equipment provided by the Contractor. *Provide 3- ring zip-lock pockets for each manual that is not factory 3-ring hole punched*. Do not include manuals loose

or inserted in binder pockets.

Section 4 - Warranties:

- Copy of Structured Cabling System Contractor's and 3 year warranty. *Enclose in a 3-ring clear plastic sheet protector.*
- Copy of Manufacturer's printed warranty for each item of equipment. *Enclose in a 3-ring clear plastic sheet protector.*

Section 5 - Transmittal of Loose Items:

Copy of transmittal to the Owner of all loose items such as patch cords, spare surge protectors, spare parts, etc. signed-off by the Owner. *Enclose in a 3-ring clear plastic sheet protector.*

Section 6 - Documentation of Training:

Documentation of training signed-off by the Owner's Project Manager. *Enclose in a 3-ring clear plastic sheet protector.*

Section 7 - Cable Test Results:

Part 1 – RCDD Certification:

Provide written Certification of Contractor's RCDD, stating that all fiber optic, Category 6 and Category 6A cables have been tested in compliance with the contract documents and have met or exceeded the requirements stated therein. *Enclose in a 3- ring clear plastic sheet protector.*

Part 2 – Executive Summary:

Provide Hardcopy Summary Report of test results in the following divisions:

- Category 6 and Category 6A Cabling – Generate report directly from Fluke Networks 'Linkware' software.
- Fiber optic backbone cabling – Generate report directly from Fluke Networks 'Linkware' software.

*Enclose each report in a 3-ring clear plastic sheet protector.*

Part 3 – Fiber Optic Cables:

Provide detailed printed test results for all fiber optic cables. *Test results shall be printed on a laser printer. Enclose*

*hardcopy in a 3-ring clear plastic sheet protector.*

Part 4 – Category 6 and Category 6A Cables:

Provide CD with Category 6 and Category 6A cable text only test results in native Fluke Networks 'Linkware' software *.FCM format and in Adobe Acrobat *.PDF format*. Place CD in 3-ring clear plastic CD jacket.*

Part 5 – Fiber Optic Backbone Cables:

Provide CD with fiber optic backbone cable test results in native Fluke Networks 'Linkware' software *.FCM format and in Adobe Acrobat *.PDF format*. Place CD in 3-ring clear plastic CD jacket.*

Section 8 - Patch Cord Spreadsheet (voice and data):

Provide Hardcopy and CD of Excel Spreadsheet file. *Enclose hardcopy in a 3-ring clear plastic sheet protector. Place CD in 3-ring clear plastic CD jacket.*

Section 9 – Annotated Adobe Acrobat *.PDF As-Built Drawings.

Provide 11"x17" hardcopy laser prints and CD of *.PDF files. *Enclose hardcopy in a 3-ring clear plastic sheet protector. Place CD in 3-ring clear plastic CD jacket.*

B. As-Built AutoCAD Drawings:

Provide the same AutoCAD drawings as required under paragraph "Pre-Installation AutoCAD Drawings". Modify and correct to accurately reflect the finished installation. Provide five (5) hard-copies and two (2) sets of electronic media.

Submit As-Built AutoCAD Drawings to the Engineer at the Substantial Completion Inspection. Provide transmittal letter addressed to the Engineer indicating that the Contractor is providing five (5) hard-copies and two (2) sets of electronic media of the As-Built AutoCAD Drawings.

C. Red-Line Record Documents:

Refer to paragraph "CONTRACTOR'S RECORD DOCUMENTS". Provide Record Documents, updated in red pen, to accurately reflect the finished installation.

Submit Red-Line Record Documents over to the Engineer at the Substantial Completion Inspection. Provide transmittal letter addressed to the Engineer indicating that the Contractor is providing one (1) set of Red-Line Record Documents.

D. Annotated Adobe *.PDF A-Built Drawings:

The Engineer will provide a full set of Adobe Acrobat *.PDF format As-Built Drawings to

the Contractor. The Contractor shall be required to annotate (redline) the *.PDF format drawings using Adobe Acrobat to reflect all changes recorded in the field as required by the paragraph "CONTRACTOR'S RECORD DOCUMENTS". The Contractor shall provide a copy of the
*.PDF files on CD with each set of O&M Manuals and shall provide an additional copy on CD to the Engineer. The Contractor shall also provide 11”x17” hardcopy laser prints of *.PDF drawings in each O&M Manual.

## 3.10 SUBSTANTIAL COMPLETION

Complete Final Checkout of system operation, Final Checklist, Cable Test Results, O&M Manuals and Record Documents prior to Substantial Completion. The Contractor's project manager and project senior technician shall be present for the Substantial Completion Inspection.

## 3.11 OWNER PERSONNEL TRAINING

Owner personnel training shall be provided for the Structured Cabling System. The cost of training shall be included in the cost of the system. Two copies of all manuals and training material shall be supplied to the Owner’s Project Manager at no additional cost.

The Owner’s Project Manager shall be notified prior to each training session and may participate in the training at his or her discretion.

All instruction shall be presented in an organized and professional manner by personnel who are thoroughly familiar with the installation and who certified by the manufacturer of the specific system and/or equipment for which they are providing training.

The Structured Cabling System Contractor shall provide documentation of all training (including names of personnel present at each training session) to the Engineer at the Final Completion Inspection. The documentation shall be signed-off by the Owner. The documentation shall be three-hole punched and ready for insertion in the O&M manuals.

A. Structured Cabling System Training:

Subsequent to Substantial Completion but prior to Final Completion, the Contractor shall provide on-site training to Owner personnel on the operational use of the Structured Cabling System and all related equipment.

The Structured Cabling System Contractor shall schedule a time to provide not less than one (1) hour of formal training to Owner personnel on the Structured Cabling System. The Structured Cabling System Contractor shall provide an additional two (2) hours of follow-up training on the system when requested by the Owner at any time during the warranty period.

Structured Cabling System training shall include a "walk-through" of the systems to identify and locate closets, panels, and important system components, a discussion of overall system concepts and configuration, specific instruction in labeling and patch cord move/changes, a review of the as-built drawings, a review of the system verification and acceptance documentation, and guidelines for basic trouble-shooting and operation of the Structured Cabling System and all related equipment.

## 3.12 FINAL COMPLETION

Following completion of punch list items generated by the Engineer following the Substantial Completion Inspection, the Contractor shall notify the Engineer in writing, stating that all punch list items have been completed.

## 3.13 WARRANTY

The Structured Cabling System Contractor warrants all work performed by him directly and all work performed for him by others for a period of three years. Any work, material or equipment which during the warranty period is, in the opinion of the Engineer or the Owner's Project Manager, defective or inferior and not in accordance with the contract documents, shall be made good at no additional cost to the Owner, including any other work which may have been damaged because of such deficiencies. The Contractor shall be the contact person and the person responsible for coordinating all warranty work for the Owner.

When equipment cannot be repaired at the site, the Contractor shall be completely and solely responsible for the coordination and completion of equipment repairs, including pickup at the project site, transportation and shipping costs to and from the repair site, and reinstallation and reintegration into the system. Equal or better loaner equipment shall be provided and installed by the Contractor any time equipment cannot be repaired at the site, so that the system is maintained in continuous working order as before the equipment failed.

A. Special Warranty – Structured Cabling System:

The Structured Cabling System Contractor shall be fully able to provide the following warranty if requested by the Owner.

All materials, equipment and workmanship incorporated in the work shall be guaranteed by the Structured Cabling System Contractor and the Structured Cabling System Manufacturer for a period of 25 years from the date of Final Completion of the project and Final Acceptance by the Owner. See paragraph 1.4.A Special Warranty - Structured Cabling System for detailed requirements. The Structured Cabling System Contractor shall provide all necessary documentation required by the Structured Cabling System Manufacturer to properly register the system with the manufacturer for warranty purposes. The Structured Cabling System Manufacturer shall issue certificates of warranty signed by a permanent employee of the Structured Cabling System Manufacturer who is authorized by the senior officers of the company to certify the fiber optic, Category 6 and Category 6A cabling systems. Original certificates of warranty shall be provided to the Owner, with copies to the Engineer.

**END OF SECTION 27 00 00**

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# SECTION 28 10 00 – ELECTRONIC ACCESS CONTROL SYSTEM

## PART 1 - GENERAL

### 1.1 SCOPE

A. This specification delineates the requirements for a complete Electronic Access Control with integrated Intrusion Alarm System as specified herein and as indicated on the drawings.

B. The scope is to provide a complete and warranted system ready for full operation in accordance with the contract documents and additional direction provided by the Owner to the Access Control System Contractor. The installation shall include all accessories and appurtenances required to provide a complete and fully operational system. Any materials not specifically mentioned in these specifications or not shown on the drawings but required for a complete and finished installation shall be furnished and installed at no additional cost to the Owner.

C. Refer to the access control and intrusion alarm system drawings, electrical drawings, architectural drawings and door hardware specifications for additional information regarding the scope of related work for the General Contractor and each subcontractor. Coordinate all work closely with the Owner's Project Manager, General Contractor, Electrical Contractor, Structured Cabling System Contractor, and door hardware provider.

### 1.2 ACCESS CONTROL SYSTEM CONTRACTOR ALLOWANCE

A. The Construction Manager/General Contractor shall include a complete Access Control System with Intrusion Alarm for this project provided by a specialized Access Control System Contractor with related work provided by the SCSC and the Electrical Contractor. The Access Control System Contractor shall be a direct subcontractor to the General Contractor. See drawings for additional information.

B. The Owner is standardized on Vanderbilt SMS Enterprise Software for a multi-site web-based access control system management, monitoring and control system beginning with this project.

C. The Access Control System Contractor shall be Vanderbilt SMS certified beginning not less than one year prior to bids, shall be well experienced in the integration of an Access Control System of the type and size required for this project into Vanderbilt SMS and shall meet all additional qualifications stated in the specifications and drawings. Provide letter from Vanderbilt attesting to current certification as part of the bid proposal.

D. **The Access Control System Contractor must be certified and qualified and must be on the list of subcontractors at the time of Bid submittal.**

E. The scope of work shall include the Access Control System with intrusion alarm complete with all work indicated on the drawings and described in the specifications, all work described in the Access Control System Contractor's cost proposal and associated statement of work, all other materials, equipment and work required for a complete system, all wiring and cabling (except as indicated below for category 6 network cabling by the SCSC), and all programming and setup required to make the system fully operational and functional to the satisfaction of the Owner.

F. The Access Control System Contractor shall provide all wiring for each sub-system, except that Category 6 cabling to the Access Control System for emergency notification and Category 6 cabling to Access Control System Panels for Ethernet Network interfaces shall be provided by the Structured Cabling System Contractor under Division 27.

G. Related work to be provided by others but not included in the scope of work for the Access Control System Contractor shall include conduit for all Access Control System wiring and cabling and all power and grounding required for the Access Control System. The Electrical Contractor shall be responsible for coordinating the associated conduit, power and grounding work with the Access Control System Contractor - but the scope of conduit, power and grounding work shall not be less than that described on the drawings.

H. The Access Control System Contractor shall include but not be limited to the following sub-systems and all related work:

Access Control System.
Intrusion Alarm System for exterior doors (using door position switches and request to exit factory provided in electrified locksets and exit devices) and integrated into the access control system.

Remote Notification Interfaces.

All other work indicated on the drawings and all other work required for a complete Access Control and Intrusion Alarm System.

I. The Access Control System Contractor shall be responsible for providing a final detailed design for each sub-system incorporating the systems indicated schematically on the drawings with all additional components and features required for complete systems based on Owner standards and specific direction for this project.

J. The Access Control System Contractor project manager shall periodically visit the site and inspect the work in progress. Project manager site visits shall be made not less than once per week when the job is in active progress. The project manager shall prepare a field report for each site visit for submission to the Owner. The project manager shall sign off on all system test results.

## 1.3 EQUIPMENT PROVIDER

The contractor shall procure all Access Control System equipment from a factory authorized reseller in the geographical area of the project for continued support.

## 1.4 RELATED REQUIREMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

Electrical Specification Sections regarding conduit apply to work under this section, with the additions and modifications specified herein and on the drawings. The special requirements indicated on the drawings and in this specification section for Access Control System conduit shall take precedence over any requirements specified in Electrical Specification Sections.

All conduit and related work shall be provided by the project electrical contractor using tradesmen who are skilled and experienced in the types of conduit installations indicated in the bid documents. See drawings for conduit requirements.

Refer to Division 27 Communications Structured Cabling System for related work by the Communications Structured Cabling System Contractor who shall provide a Category 6 connection to the Access Control System for emergency notification and a Category 6 Ethernet network connection (two Category 6 cables) to each Access Control System panel.

## 1.5 EXAMINATION OF SITES AND TOTAL SYSTEM RESPONSIBILITY

Prior to providing a proposal for this work, each bidder shall examine the drawings, specifications, and other contract documents to inform himself/herself thoroughly regarding any and all conditions and requirements that may in any manner affect the work to be performed under the contract.

Any additional equipment and accessories required for the installation and operation of the complete operating system not specifically required by the bid documents shall be provided and the cost borne by the contractor.

The contractor remains the owner of all equipment provided under this contract and is responsible for all risk of loss or damage to the equipment from any source up to and including the date and time of final acceptance by the Owner. Upon the date of commencement of the warranty period, the Owner shall assume full ownership of the equipment.

## 1.6 QUALITY ASSURANCE

Materials shall be new and shall be the best of their respective kinds. All work shall be accomplished in a workmanlike manner in keeping with the best practices and highest standards of the Electronic Access Control & Panic Alarm System industry.

Protect materials and equipment from physical or environmental damage during shipping, storage and installation. Equipment and materials shall be received at the site in new condition and shall be maintained in new condition throughout the installation process. Damaged or deteriorated equipment and materials will not be acceptable. The Contractor shall be responsible for the safety and condition of all materials and equipment, whether stored or installed, until final acceptance by the Engineer and the Owner.

## 1.7 CODES AND STANDARDS

All work done under this contract shall be performed in accordance with the most recent issue of the following codes and standards. Where there is a perceived conflict between a standard and the contract documents, the Contractor shall perform the work as directed by the Engineer. Where no specific method or form of construction is called for in the Contract Documents, the Contractor shall comply with code requirements when carrying out such work.

A. Codes:

a. Florida Building Code
b. National Electrical Code (NFPA 70)

c. Life Safety Code (NFPA 101)
d. Florida Fire Prevention Code 8th Edition
e. National Electrical Safety Code (NESC)

B. Standards: All electrical materials, installation and systems shall meet the requirements of the following standards, including the latest addenda and amendments:

a. American National Standard Institutes (ANSI)
b. Institute of Electrical and Electronics Engineers (IEEE).
c. National Electrical Manufacturer's Associations (NEMA).
d. National Fire Protection Association (NFPA).
e. Occupational Safety and Health Act (OSHA).
f. Underwriter's Laboratories, Inc. (UL).
g. Electronic Industry Association (EIA).
h. Telecommunication Industry Association (TIA).
i. American Society of Industrial Security (ASIS)

## 1.8 SUBMITTALS

A. Submit three copies of the manufacturer's catalog data and pre-installation drawings to the Engineer for approval prior to commencing work or ordering materials. Receive approval of the Engineer in writing for each item of submittals prior to commencing work.

B. Manufacturer's Catalog Data: Submit the producer's standard descriptive data sheets for each type of product being provided. Provide products in accordance with the drawings. Provide complete data sheets bearing the printed logo or trademark of the manufacturer. Mark each copy of the data sheets for the specific product being provided with an identifying mark, arrow, or highlighting. Submittals without such identifying marks shall be rejected without comment for resubmittal.

Submit the following items and all other items required for a complete system:

a. Cabling, each type
b. Cabling connectors
c. Card Reader, each type, with all accessories including enclosures
d. All card reader factory mounting plates and other accessories
e. Access Control System panels
f. Access Control System power supplies
g. Fire-stopping, each type (each UL listed Assembly)
h. All other materials and equipment indicated on the drawings to be furnished under this section, whether specifically listed here or not.
i. All other materials and equipment required for complete and fully functional system in accordance with direction from the Owner, whether indicated elsewhere or not.
j. All other information indicated on the contract drawings, and all additional information required by the Engineer.

## 1.9 CONTRACTOR'S RECORD DOCUMENTS

The Access Control System Contractor shall maintain a full set of contract documents at the job site at all times, consisting of specifications, drawings, addenda, pre-installation submittals, change orders, and engineering directives. The record documents shall be updated by the Contractor, in red pen and on a daily basis, to show the following:

a. Final location of all Card Readers.
b. Final locations of all access control system panels and power supplies.
c. Final location of all other system components.
d. Any changes to the work authorized by the Architect/Engineer.
e. Any other pertinent information that may be of value to the Owner in operating and maintaining the system.

The Contractor's record documents shall be available for viewing by the Engineer or the Owner at the site at any time and shall be presented and reviewed by the Contractor at each construction progress meeting. The record documents shall be clearly marked "Record Set", shall be kept in a protected location, and shall not be used for general construction purposes. The record documents shall be provided to the Engineer at the close of the project.

The Engineer will provide a full set of Adobe Acrobat *.PDF format drawings to the Contractor. The Contractor shall be required to annotate (redline) the Adobe Acrobat *.PDF format drawings using Adobe Acrobat to reflect all information recorded in the field. The Contractor shall provide a copy of the Adobe Acrobat *.PDF files on CD with each set of O&M Manuals and shall provide an additional copy on CD to the Engineer. The Contractor shall also provide 11”x17” laser prints of Adobe Acrobat *.PDF drawings in each O&M Manual. Electronic files of the Engineer’s AutoCAD floor plan drawings will be provided to the Contractor upon request.

## PART 2 - PRODUCTS

### 2.1 GENERAL

All materials, equipment, and devices shall be new and unused, of current manufacture and of the highest grade, free from defects.

All products shall be the manufacturer and model or part number specified. Bid shall be for new equipment only. Newly manufactured (containing used or rebuilt parts), remanufactured, rebuilt, reconditioned, newly remanufactured, used, shopworn, demonstrator or prototype equipment is not acceptable and will be rejected. If required by the Engineer, the Contractor shall provide a written certification from the manufacturer referencing the serial number each item of equipment and stating that the equipment is new.

All materials, equipment and devices shall, as a minimum, meet the requirements of UL where UL standards are established for those items, and the requirements of NFPA 70.

All like items of material or equipment shall be the same product of the same manufacturer.

All materials and equipment shall be a standard catalogued product of a manufacturer regularly engaged in the manufacture of similar products.

Where a model or part number is indicated in error for any reason, the Contractor shall verify the intent of the Engineer prior to providing a bid proposal and shall provide the product intended by the Engineer. Where a manufacturer has updated or improved a product subsequent to issuance of the bid documents by the Engineer, the Contractor shall provide the updated or improved product at no additional cost to the Owner.

## 2.2 PRODUCT SPECIFICATIONS

To ensure a uniform basis for bidding, and to standardize the Owner's facilities, base all bids on the particular systems, equipment and materials specified.

See drawings for all product requirements not indicated in these specifications. The Structured Cabling Contractor shall be responsible for providing and installing all components indicated in these specifications and on the drawings, unless specifically indicated to be provided by others.

# PART 3 - EXECUTION

## 3.1 GENERAL

The installation shall be in strict accordance with all applicable codes and standards, the respective manufacturer's written recommendations, and the contract drawings and these specifications.

All materials, equipment, and devices shall be new and unused, of current manufacture and of the highest grade, free from defects. Workmanship shall be of the highest grade in accordance with modern practice.

The installed system shall be neat, clean, and well organized in appearance. Provide working clearances for normal system operation, reconfiguration and repair.

The Access Control System Contractor shall test each cable as required by NEC and all requirements of the cable manufacturer and the manufacturer of connected equipment for operational and warranty compliance. Document results of testing and submit to Engineer for review and approval. The test log shall include the system component identifier, the test date, the initials of the technician who tested the cable, and the test results.

All equipment mounting heights and locations shall be in accordance with the Americans with Disabilities Act (ADA). Coordinate with the Architect.

All wiring shall be terminated on terminal blocks – each wire shall be terminated using crimp on ring style lug connectors. Wire nuts or B-style crimp on connectors are not acceptable.

Run a single jacketed cable containing all necessary individually insulated cables to operate the access control system with all related functions at each secure door. The cable shall be continuous with no splices from the serving Access Control System Panel to the point of connection at the secure door served.

### 3.1.1 Conduit Installation:

See drawings for conduit requirements.

### 3.1.2 Cabling Installation:

Access Control System cabling shall be run continuously in conduit without exception.

Do not pull cables in conduits until plastic insulating bushings have been installed. Cables installed in conduits without plastic insulating bushings shall be removed and replaced with new cables. Rack conduits and run together wherever possible.

The Contractor, in providing a bid for the system in accordance with the contract documents, agrees to install all cabling in the conduit and wireway paths indicated in the contract documents, or to provide larger conduit and wireway paths as he deems necessary, at no additional cost to the Owner. The Contractor shall be fully responsible for any and all damage to cabling that may occur during the installation and shall replace any damaged cabling with new cabling of the type specified for the application.

Firestop all conduit penetrations of all walls that extend to the underside of the roof deck above. Firestop all conduit penetrations of all walls that do not extend to the underside of the roof deck above but are indicated as fire rated on the drawings. Accomplish firestopping using UL classified systems with fire rating equal to or greater than the fire rating of the floor or wall assembly penetrated. Firestop systems shall be 3M, Nelson or Engineer approved equal. Install in strict accordance with the manufacturer's printed instructions and the conditions of the UL approval for each firestop system used.

All cable penetrations of walls that do not extend to the underside of the roof deck above shall be sealed smoketight and acoustically with smoke-sound caulking UL listed for the purpose such as USG Firecode, STI Smoke 'N' Sound, or Hilti CP.

## 3.2 CARD READER LOCATIONS

Card Reader locations indicated on the drawings are approximate – see "Card Reader Location Note" on the drawings.

The General Contractor shall schedule meetings at the site prior to commencement of any installation activities by the Access Control System Contractor and the system rough-in provider and additionally as construction proceeds to coordinate the exact location of each card reader prior to installation. The meetings shall include the General Contractor, the Owner's Project Manager, the Access Control System Contractor, and the Electrical Contractor. Final card reader locations may be placed up to 10 feet away from locations shown without additional cost to the Owner. Particular attention shall be given to coordination of card reader locations relative to clear visibility, easy user access, and open direct path to controlled door after unlock.

The Access Control System Contractor shall install the card readers in accordance with the manufacturer's printed installation instructions and the mounting requirements indicated on the drawings, except that final reader locations shall be determined as indicated above. All card readers shall be flush mounted.

After final card reader locations are determined and the readers are mounted and wired the Access Control System Contractor shall test the operation of each reader with the Owner's Project Manager and security personnel.

## 3.3 SYSTEM SETUP AND PROGRAMMING

All required headend equipment installation, setup and programming shall be provided by the Access Control System Contractor in accordance with established Owner standards or as directed by the Owner.

The Access Control System Contractor shall also complete all work related required for the full application of the Access control System to the Access Control Systems for this project as directed by and to the satisfaction of the Owner's Project Manager and security personnel.

In general use all setup features provided by the manufacturer to provide the best system operation under all conditions of use. Describe to the Owner all available features of the system and provide setup as directed by the Owner and for the best overall operation and performance of the system as a whole for the intended purpose.

Assign each secure door a schedule and assign door types. Setup time schedules and operating modes for each unique secure door type. Coordinate operating modes for each secure door type at different times of the day, week and year in detail with the Owner. Coordinate regularly scheduled events as well special events. Setup and program system accordingly for access to the facility by use of card readers using Owner issued employee proximity cards. Assign credentials provided by the Owner and provide all related information entry into software if so directed by the Owner.

Setup system user interface stations selected by the Owner for through the facility LAN and Web. Setup user/host authentication, user access and user priorities.

Setup Intrusion Alarm System for arm/disarm as indicated on the drawings and for alarm notification as directed by Owner to include all methods and recipients of local and remote notification as directed by the Owner.

Coordinate all network interfaces with the Owner's IT and security personnel. Contact the Owner's project manager to schedule meetings with required personnel.

## 3.4 SYSTEM VERIFICATION AND OWNER'S ACCEPTANCE TEST

Proof of performance of the Access Control System to include a full system operational test shall be conducted in the presence of the Owner's Project Manager and Owner personnel. As part of proof of performance demonstrate system operation to Owner's personnel.

The Contractor shall conduct a final inspection and pretest all equipment and system features required for project. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.

The Contractor shall submit a request for Owner Acceptance Test in writing to the Owner's Project Manager, no less than fourteen days prior to the requested test date. The request for Acceptance Test shall be accompanied by a certification from Contractor that all work is complete and has been pre-tested, and that all corrections have been made.

During Acceptance Test, Contractor shall demonstrate all equipment and system features to the Owner. The Contractor shall remove covers, open wiring connections, operate equipment, and perform other reasonable work as requested.

Any portions of the work found to be deficient or not in compliance with the Drawings and Specifications will be rejected. The Contractor shall promptly correct all deficiencies and submit a request in writing to Owner's Project Manager for a follow-up Acceptance Test.

## 3.5 CHECKOUT

Subsequent to testing and verification and prior to the first day of normal operation following start-up, the contractor shall be responsible for checking out the system to verify that it is operating properly and performing in compliance with the equipment manufacturer's specifications and the specifications. The checkout shall include a System Inspection Checklist to fully document checkout.

## 3.6 SUBSTANTIAL COMPLETION

The Access Control System Contractor shall complete the installation of the Access Control System prior to the scheduled date for Substantial Completion to allow sufficient time for Owner Training and final system setup such that the Access Control System shall be fully operational and ready for use on the date of Substantial Completion.

## 3.7 FINAL COMPLETION

Following completion of the Substantial Completion punch list items and the initial performance period, the contractor shall notify the Engineer. The Engineer will conduct a final completion inspection. Upon determining that all punch list items have been satisfactorily completed, the Engineer will declare the project finally complete. For the purposes of this contract the terms Final Completion, Final Acceptance, and Final System Acceptance are synonymous.

## 3.8 DOCUMENTATION

A. Red-Line Record Documents:

Refer to paragraph "CONTRACTOR'S RECORD DOCUMENTS". Provide Record Documents, updated in red pen, to accurately reflect the finished installation.

Submit Red-Line Record Documents over to the Engineer at the Substantial Completion Inspection. Provide transmittal letter addressed to the Engineer indicating that the Contractor is providing one (1) set of Red-Line Record Documents.

B. Annotated Adobe *.PDF A-Built Drawings:

The Engineer will provide a full set of Adobe Acrobat *.PDF format As-Built Drawings to the Contractor. The Contractor shall be required to annotate (redline) the *.PDF format drawings using Adobe Acrobat to reflect all changes recorded in the field as required by the paragraph "CONTRACTOR'S RECORD DOCUMENTS". The Contractor shall provide a copy of the *.PDF files on CD with each set of O&M Manuals and shall provide an additional copy on CD to the Engineer. The Contractor shall also provide 11”x17” hardcopy laser prints of *.PDF drawings in each O&M Manual.

C. O & M Manuals:
The contractor shall provide operating and maintenance manuals covering all equipment and materials furnished under this contract. The O & M manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the System. The information shall include detailed documentation equipment configuration. A complete recommended spare parts inventory list shall be included with the lead time and expected frequency of use for each part clearly identified.

A quantity of three (3) 8-1/2" x 11" loose leaf 3-ring binders with clear vinyl overlay designed to receive identification inserts shall be provided. The manuals shall contain the following sections:

a. Cut sheets for all equipment.
b. Detailed wiring diagrams and panel drawings
b. Installation instructions.
c. Operating and maintenance instructions.
d. Recommended spare parts inventory list.
e. User's Guides and technical reference guides.
f. Copy of one year warranty.

Provide a list with name, address, contact person, and phone number for two separate contacts with name and telephone number for warranty service and the manufacturer of each item of equipment with telephone number and sources of supply for parts.

3.9 USER TRAINING

Subsequent to Substantial Completion but prior to Final Completion, the Contractor shall provide on-site training to Owner personnel on the operational use of the Electronic Access Control & Panic Alarm System and the all related equipment.

The Access Control System Contractor shall schedule a time to provide not less than eight (8) hours of formal training to Owner personnel on the Access Control System, divided into two four (4) hour sessions, one prior to building occupancy and the second following building occupancy at a time directed by the Owner. See drawings.

Access Control System training shall include a "walk-through" of the systems to identify and locate closets, panels, and important system components, a discussion of overall system concepts and configuration, specific instruction in labeling, a review of the as-built drawings, a review of the system verification and acceptance documentation, guidelines for basic trouble-shooting and detailed instructions in the operation of all aspects of the Electronic Access Control & Lockdown/Panic Alarm System and all related equipment.

3.10 WARRANTY

All equipment including material used in the installation thereof shall be warranted for one year by the Access Control System Contractor against mechanical, electrical, and workmanship defects. In the event defects become evident within the warranty period, the Contractor shall repair or replace the defective parts and materials at no additional cost to the Owner. The warranty period shall start with the date of final acceptance. The warranty shall apply to all equipment provided under the provisions of this contract regardless of the location. Warranties submitted with bids, either appearing separately or included in pre-printed literature and price lists, shall not be acceptable and provisions herein take precedence.

**END OF SECTION 281000**

## SECTION 28 46 21.11 – ADDRESSABLE FIRE ALARM SYSTEMS

PART 1 - GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this Section.

1.2 Division-26 Electrical Sections apply to work of this Section.

A. The fire alarm system shall be installed by a state certified fire alarm system installation Contractor.

B. It is the intent of this specification to provide an individual complete and operational low voltage, time-division multiplexed, addressable intelligent fire alarm system as described herein. The system shall include, but not be limited to: control panels and power supplies, standby power supply and battery, alarm initiating and indicating appliances and devices, monitor and supervision devices, system wiring, and accessories required to provide and install a complete and software operational system. All equipment and installation shall comply with the requirements of these specifications and the related Drawings. Items specified by either shall be as if specified by both. The individual system specified herein shall be networked as described herein.

C. The equipment and installation shall comply with the current provisions of the following standards:

National Fire Protection Association Standards:
NFPA 70 National Electric Code
NFPA 72 National Fire Alarm Code
NFPA 101 Life Safety Code
Underwriters Laboratories Inc.

Underwriters Laboratories Inc. for use in fire protective signaling systems shall list the system and all components. The UL Label shall be considered as evidence of compliance with this requirement. The equipment shall be listed by UL under the following standards as applicable:

| | |
|---|---|
| UL 864/UOJZ, APOU | Control Units for Fire Protective Signaling Systems. |
| UL 1076/APOU | Proprietary Burglar Alarm Units and Systems. |
| UL 268 | Smoke Detectors for Fire Protective Signaling Systems. |
| UL 268A | Smoke Detectors for Duct Applications. |
| UL 521 | Heat Detectors for Fire Protective Signaling Systems. |
| UL 228 | Door Holders for Fire Protective Signaling Systems. |
| UL 464 | Audible Signaling Appliances. |
| UL 1638 | Visual Signaling Appliances. |
| UL 38 | Manually Activated Signaling Boxes. |
| UL 1971 | Visual Signaling Appliances. |
| UL 1481 | Power Supplies for Fire Protective Signaling Systems. |
| UL 1711 | Amplifiers for Fire Protective Signaling Systems. |

Any equipment not bearing a UL Label shall be removed and replaced with labeled equipment at the Contractors' expense.

Americans with Disabilities Act (ADA)

In the case of any discrepancy between these specifications, the project drawings, and any applicable local codes, the installed Fire Alarm System shall comply with the most stringent requirement.

D. The system and all components shall be listed by Underwriter's Laboratories for specific application

as fire alarm equipment. The UL label shall be prima facie evidence of compliance with this requirement. Any equipment not bearing a UL label will be unacceptable and will be removed and replaced with labeled equipment at the Contractor's expense.

1.3 SUBMITTALS:

A. Submit the producer's standard descriptive data sheets for each type of product being provided. Mark the data sheet for the product being provided with an identifying mark or arrow. Complete data sheets bearing the printed logo or trademark of the fire alarm control panel manufacturer for the following equipment:

1. System Control Panel.
2. System Power Supply.
3. Standby Power Supply.
4. Each type of automatic smoke detector and fire detector.
5. Manual alarm initiating station.
6. Audible/Visual alarm indicating appliances.
7. Voice Evacuation Equipment
8. Any other items required by the Project Drawings or Specifications.

B. Evidence of listing of all proposed equipment by UL for application as fire alarm equipment.

C. Submit a scaled "point-to-point" wiring diagram showing the connections to the equipment and terminal cabinets. Indicate the equipment numbers, terminal numbers, wire numbers, zone numbers, wire colors, junction box sizes, and conduit sizes. Include the connections for the Mechanical Systems and the Fire Detection and Alarm System. The submittal shall be made for approval prior to the installation of the wiring in the raceways. Make a clear statement that all circuits shall be terminated on terminal strips and that wire nuts will not be allowed. Electronic floor plans are available from the Architect.

D. A custom wiring diagram for the building showing wiring to each individual appliance and device.

E. Submit voltage drop calculations for all alarm circuits.

F. Submit battery calculations for the fire alarm panel with all devices under supervisory and alarm conditions.

G. Evidence of certification of the proposed fire alarm Contractor by both the State of Florida Department of Professional Regulation.

H. Written certification by the fire alarm Contractor that no power supply or circuit on the system has an electrical load greater than 80% of its rated capacity.

I. No equipment shall be purchased by the Contractor for the fire alarm system until the Architect has approved the above submittals in entirety and returned them to the Contractor.

J. It is the Contractor's responsibility to meet the entire intent of the specifications. Approved submittals shall only allow the Contractor to proceed with the installation and shall not be construed to mean that the Contractor has satisfied the requirements of these specifications.

K. The contractor shall provide the following:

1. Hourly, Non-Standard, Holiday, and Overtime Service Rates.
2. Semi-Annual inspection rates. These services are to be performed by factory trained and authorized personnel, for this installed System with the submittal. These hourly service rates shall be guaranteed for a three-year period beyond the three-year warranty period. The Contractor shall also provide Annual Inspection Rates for System Testing in compliance with

NFPA 72 requirements for three years of system operation. Proof of the level of factory training and authorization of the servicing Contractor shall be included in the submittal.

a. Evidence of listing by Underwriters' Laboratories for all proposed equipment for use as Fire Alarm equipment. (Ref.: Underwriters' Laboratories, Section UOJZ).
b. A Single Line System Block Diagram and written System Operational Overview.
c. Complete calculations showing the electrical load on the following system components:
    1) Each system Power Supply
    2) Each standby Power Supply (batteries)
    3) Each Notification Appliance Circuit.
    4) Each auxiliary control circuits that draw power from any system power supply.
d. Field Connection Drawings: A complete set of drawings, one for each Fire Alarm Control Panel module which has any external (field) wiring connected to it, and one for each system detector, module or signaling appliance, shall be supplied. The Field Connection Drawings shall be done under AutoCAD Version 2020 or later. They shall be provided on computer diskette and in paper format. Building floor plans of contract sheets will be furnished on diskette to the Contractor by the Architect without charge.
e. Warranty Statement from the manufacturer shall be provided as part of the submittal package. This warranty statement will state a 3 year period of warranty for all of the products proposed for the project, and shall include the name and address of the authorized manufacturers' agent who will honor any and all warranty claims.
f. Written Certification by the Fire Alarm Contractor that no power supply or circuit in the system has an electrical load greater than 80% of its rated capacity.
g. A scaled plan of building showing the placement of each individual item of fire alarm equipment as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway.

1.4 QUALITY ASSURANCE:

A. Each and all items of the fire alarm system shall be listed as a product of a single fire alarm manufacturer under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the "UL" label. All control equipment shall be listed under UL Category UOJZ as a single control unit. Partial listing will not be acceptable.

B. All control equipment shall have transient protection devices to comply with UL 864 requirements.

C. Manufacturer's Qualifications: All fire alarm equipment shall be the product of one manufacturer. System appliances and devices not manufactured by the control panel manufacturer shall be products regularly distributed by the control panel manufacturer and cross-listed by Underwriter's Laboratories for compatibility with the system control panel.

D. Installer's Qualifications: The installation and testing of all components of the system shall be performed by a Contractor holding a current certification issued by the State of Florida Department of Professional Regulation. The Contractor shall be certified as either an Alarm System Contractor – Type 1 or an Unlimited Electrical Contractor.

F. The fire alarm Contractor shall be an experienced firm regularly engaged in the layout and installation of automatic fire alarm systems. The Contractor shall have successfully completed the installation, testing, and warranty of systems of the scope of the largest system on this project at least three years prior to bid, and have regularly engaged in the business of fire alarm systems contracting continuously since.

G. The fire alarm Contractor shall have been certified by the State of Florida Department of Professional Regulation to install fire alarm systems, have been NICET Level III certified, and certified by one of the above listed approved equipment manufacturer to perform installation, testing, adjustment, maintenance, and repair on the approved manufacturer's equipment prior to the date of bid. The proposed fire alarm Contractor shall commence no work on the project until he furnishes evidence, satisfactory to the aforementioned certifications and receives notice to proceed with the installation from

the Architect.

H. Firms shall have been factory authorized service organization and stock spare parts.

1.5 WARRANTY AND MAINTENANCE:

A. The Contractor shall supply a 3-year warranty from date of commissioning for all Control System and Field Devices and appliances. The Contractor shall warrant the installed fire alarm system to be free from defects of material and installation for a period of 3 years from acceptance by the Architect. Any deficiencies shall be immediately corrected at no additional cost to the Owner. The Contractor shall maintain a service organization with adequate spare parts stock within 150 miles of the installation. Any defects that render the system inoperative shall be repaired within 24 hours of the Owner notifying the Contractor. Other defects shall be repaired within 48 hours of the Owner notifying the Contractor.

B. The Factory Trained and Authorized Contractor who Designed and Installed this system shall provide a separate maintenance contract for a period of 3 Years from the date of system warranty expiration. As part of the systems maintenance, the installing Contractor will provide printed out reports which detail the sensitivity of each smoke detector installed in the system, and the date of the report.

C. The Fire Alarm System supplied shall include a store of spare system sub-assemblies and field devices for use as emergency service stock. As a minimum, the spares stock shall include 2% of each different type of field connected device.

PART 2 - PRODUCTS

This Fire Alarm System Specification must be conformed to in its entirety to ensure that the installed and programmed System will function as designed, and will accommodate the future requirements and operations required by the building Owner. All specified operational features will be met without exception.

2.1 SYSTEM OVERVIEW AND DESCRIPTION:

A. The Fire Alarm System supplied under this specification shall be a microprocessor-based direct wired peer to peer network system. The system shall utilize independently addressed, and microprocessor-based smoke detectors, heat detectors, and modules as described in this specification.

B. All Fire Alarm equipment shall be arranged and programmed to provide an integrated system for the early detection of fire, the notification of individual system building occupants, the automatic summoning of the local Fire Department, the override of the HVAC system operation, and the activation of other auxiliary systems to inhibit the spread of fire and to facilitate the safe evacuation of building occupants

C. The fire alarm equipment shall be installed in the locations shown on the project drawings.

D. The fire alarm system shall be fully supervised for the detection and reporting of the derangement of any component or circuit on the system. Signaling Line Circuits shall provide the level of performance designated as, Style 7 by UL and the NFPA. Indicating circuits shall provide the level of performance designated as Style Y by UL and the NFPA.

E. The fire alarm system shall be microprocessor driven with stored program controllers. Each panel node on the network shall use a multiple microprocessor design so that the failure of a single microprocessor will not result in a local failure. Fire alarm systems that utilize only one microprocessor for system and SLC control will not be accepted.

F. The fire alarm system shall operate from direct current having a nominal potential of 24 volts. The direct current shall be provided by a solid-state power supply connected to the building electrical sys-

tem by a dedicated branch circuit in strict compliance with Articles 725 and 760 of the NEC, and these specifications.

G. A standby power supply shall automatically supply electrical energy to the system whenever the primary power supply fails to provide the minimum voltage required for proper system operation. The standby power supply shall be an electrical battery with capacity to operate the system under maximum supervisory load for 24 Hours in Standby and then be capable of operating the system for 5 Minutes in the alarm mode. The fire alarm system shall include a charging circuit to automatically maintain the electrical charge of the battery. The fire alarm system shall include the alarm initiating and indicating appliances and devices shown on the project drawings.

H. All Control Panel Assemblies and the connected Automatic and Manual Alarm and Field Notification Appliances shall be designed and manufactured by the same company, and shall be tested and cross-listed as compatible (UOJZ) to ensure that a fully functioning system is designed and installed.

I. Provide and install all required equipment and accessories necessary for the proper operation of the system.

2.2 GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS:

All equipment furnished for this project shall be new and unused. All components and systems shall be designed for uninterrupted duty. All equipment, materials, accessories, devices, and other facilities covered by this specification or noted on contract drawings and installation specifications shall be the best suited for the intended use and shall be provided by a single manufacturer.

A. The manufacturer's representative and a verification certificate presented upon completion shall verify system installation and operations. The manufacturer's representative shall be responsible for an on-site demonstration of the operation of the system and initial staff training as defined by this specification.

B. The system shall include a manner to display field device topology.

C. In addition, As-Built riser and wiring diagrams reflecting all terminations, each programmed device characteristic including detector type, base type, serial number, sensitivity setting and wire configurations will be provided to the Architect, based on the information gathered during the verification process described above. The fully executed sworn affidavit (at the back of this section) will be provided to the Architect with the As-Built riser and wiring diagrams verifying their accuracy.

D. It shall be possible for authorized service personnel to change the personality/function of the connected intelligent devices to meet changes in building layout or environment.

E. Equipment and material furnished shall comply with the latest revisions of applicable codes and standards of Underwriters Laboratories, Inc., ANSI, NEMA and NFPA and shall be listed, approved and labeled for the applications. Except as noted, all system components shall be built and tested by the same manufacturer, providing a single source or responsibility.

2.3 Approved Manufacturers:

A. GE EST IV Series or compatible with existing system of the same.

(1) FIELD PROGRAMMING:

The system shall be programmable, configurable and expandable in the field without the need for special tools or PROM programmers and shall not require replacement of memory ICs. All pro-

grams shall be stored in non-volatile memory. The programming function shall be entered with a special password that may be changed in the field to a new value at any time by entering the old password and requesting a password change.

2.4 CONTROL PANEL OVERVIEW:

The Fire Alarm System shall be a Multi-Processor Based Network System designed specifically for Fire and Security applications. The System shall be UL listed under Standards 864 (Control Units for Fire-Protective Signaling Systems) under categories UOJZ and APOU. The specified modules shall also be listed under UL 1076 (Proprietary Burglar Alarm Units and Systems) under category APOU. All new devices and circuits shall be addressable. The new panel shall have sufficient battery capacity to handle all new devices with a 50% reserve.

A. The System shall include all required hardware and system programming to provide a complete and operational system, capable of providing the protected premises with the following functions and operations:

1. All System operational software is to be stored in non-volatile memory. Systems that utilize dynamic RAM or static RAM for program storage are unreliable and will not be accepted.
2. Control Panel disassembly, and replacement of electronic components of any kind shall not be required in order to upgrade the operations of the installed system to conform to future application code and operating system changes.
3. System response to any alarm condition must occur within 3 seconds, regardless of the size and the complexity of the installed system.
4. All initial system programming, as well as all any changes made to the system programming during the start-up and system acceptance phase, shall be made electronically, and shall not require the use of diode matrices or other hardware destructive means. All changes shall be fully documented in the as-built documentation package. Systems which store initial programming or field programming changes in battery backed memory shall not be accepted
5. The system shall allow the testing of the entire installed system (Walk Test) dependent only on the needs of the testing agency, and of the occupancy requirements of the building. The testing of the installed system shall not be defined or limited by the physical layout of the Fire Alarm System, or its application to the protected premises.
6. The Fire Alarm System shall utilize Surface Mount Technology in its internal elements to increase reliability of each system component, and the system as a whole.
7. Ground Faults localized to the network node. If ground faults occur on the field wiring of the system, then the electrical location of those field-wiring faults shall be identified and annunciated to the network node, electronic loop controller, or the device where the fault has occurred.
8. All of the operational interface hardware needed to allow the system to function, as a network, shall be included with the Fire Alarm System. No additional interfaces or electronic modules shall be required to enable the system to function as a true network.
9. The Control of any or all of the System Common Control Functions shall be automatically routed, through the system operational program, to any node of the installed system as an automatic function of the time of day and/or date.

3 VOICE EVACUATION EQUIPMENT:

A. Integrated Audio: The Fire Alarm System shall incorporate a true digital integrated audio system into the network, multiplexing 4 independent audio channels over a single pair of wires. The system shall include distributed audio amplifiers, one for each speaker circuit, for system survivability. Tone generators shall also reside in each amplifier cabinet in case of message failure. The backup tone shall be a temporal tone to allow evacuation signals to be broadcast in the protected premises in the event of a loss of data communication from the multiplexed audio riser.

A. A digital message unit shall be provided which provides up to 15 minutes of prerecorded emergency messaging. The message contained in the fully digital message unit shall be

recordable and changeable in the field on a computer. Keying of either microphone shall allow a live evacuation announcement

B. Audio Source Unit:

1. The Fire Alarm System shall be provided with the fully integrated Emergency Communications System. The Emergency Communications System shall include a paging microphone at the FACP and a remote microphone in the main theatre sound booth, digital message playback unit, and 4 fully digitized and multiplexed Audio Channels. Four dedicated page mode control switches shall provide the emergency operator with instantaneous one touch paging to safely control the staged evacuation of building occupants. Automatic programming shall dynamically group the most frequently targeted paging zones.
   a. The “All Call” switch will direct the manual page to the entire facility.
   b. The “Page to Evac” switch will direct the manual page to those building are as automatically receiving the Evacuation Signal.
   c. The “Page to Alert” switch will direct the manual page to those building are as automatically receiving the Alert Signal.
   d. The “All Call Minus” switch will direct the manual page to those building areas which are programmed to receive the auxiliary and general channel connections such as stairwells
2. The system shall have paging control switches and LEDs to support specific zone selection as shown on the plans. The zone control / displays shall confirm amplifier selection and annunciate amplifier and amplifier circuit trouble.
3. The system shall automatically deliver a preannounce tone of 1000 Hz for three seconds when the emergency operator presses the microphone talk key. Either at the FACP or the remote microphone in the main theater sound booth. A ‘ready to page’ LED shall flash during the preannounce and turn steady when the system is ready for the user’s page delivery.
4. The system shall include a page deactivation timer, which activates for 3 seconds when the emergency user releases the microphone talk key. Should the user subsequently press the microphone key during the deactivation period, a page can be delivered immediately. Should the timer complete its cycle the system shall automatically restore emergency signaling and any subsequent paging will be preceded by the pre-announce tone. A VU display shall display voice level to the emergency operator.

C. Audio Amplifiers:

1. Each audio power amplifier shall have integral audio signal de-multiplexers, allowing the amplifier to select any one of eight digitized audio channels. The channel selection shall be directed by the system software. Up to 4 multiple and different audio signals must be able to be broadcast simultaneously from the same system network node.
2. Each amplifier output shall include a dedicated, supervised 25 Vrms speaker circuit that is suitable for connection of emergency speaker appliances. Each amplifier shall also include a notification appliance circuit rated at 24Vdc @ 3.5A for connection of visible (strobe) appliances. This circuit shall be fully programmable and it shall be possible to define the circuit for the support of audible, visible, or ancillary devices.
3. Standby Audio amplifiers shall be provided that automatically sense the failure of a primary amplifier, and automatically program themselves to select and de-multiplex the same audio information channel of the failed primary amplifier, and fully replace the function of the failed amplifier.
4. In the event of a total loss of audio data communications, all amplifiers will default to the local “EVAC” tone generator channel. If the local panel has an alarm condition, then all amplifiers will sound the EVAC signal on their connected speaker circuits.
5. In the event of a loss of the fully digitized, multiplexed audio riser, the audio amplifiers shall automatically default to an internally generated alarm tone, which shall be operated at a 3-3-3 temporal pattern.
6. Audio amplifiers shall automatically detect a short circuit condition on the connected speaker circuit wiring, and shall inhibit it from driving into that short circuit condition.

7. The Audio System shall include sufficient battery standby for 5 minutes of alarm after a 24-hour building power failure.

4 CONTROL PANEL OPERATION:

A. When an alarm condition is detected by one of the systems initiating devices, the following functions shall immediately occur:

1. The system alarm LED shall flash.
2. The local sounding device in the panel shall be activated.
3. The LCD display shall indicate all pertinent information associated with the alarm and its location.
4. The appropriate status change message shall be sent to the central station by an integral digital communicator.
5. All automatic programs assigned to the alarm point shall be executed and the associated indicating devices and relays addressed and activated.

B. Operation of any manual or automatic initiating device shall sound all alarm signals and shall also sound an alarm and indicate the zone activated on the fire alarm annunciator panels. Flashing light at each audible alarm shall operate with the audible alarm device.

C. Operation of any manual or automatic initiating device shall shut down air handling units. Locations shall be as shown on the Drawings.

D. Malfunction of supervised circuits shall indicate as "Trouble" on the fire alarm annunciator panels. An audible and visual signal shall indicate trouble with provisions to silence the audible signal but not the visual indication.

E. Operation of the fire alarm system and "Trouble" shall operate the necessary contacts that may be connected via telephone lines to remote locations.

F. When a trouble condition is detected by one of the system initiating devices, the following functions shall immediately occur:

1. The system trouble LED shall flash.
2. A local sounding device in the panel shall be activated.
3. The 80-character LCD display shall indicate all pertinent information associated with the trouble condition and its location.

5 FUNCTIONAL OPERATION OF THE FIRE ALARM SYSTEM:

A. Alarm detection: When a fire alarm condition is detected by one of the system initiating devices, the following functions shall immediately occur:

1. The System alarm indicator shall flash continuously.
2. A local sounding device in the panel shall be activated.
3. The control panel display shall indicate all pertinent information associated with the alarm and its location.
4. All automatic programs assigned to the alarm point shall be executed and the associated indicating appliance circuits and control relays addressed and activated.

B. System trouble detection: When a trouble condition is detected by one of the system initiating devices, the following functions shall immediately occur:

1. The System Trouble indicator shall flash.
2. A local sounding device in the panel shall be activated.
3. The control panel display shall indicate all pertinent information associated with the trouble

condition and its location.

4. However, unacknowledged alarm messages shall have priority over trouble messages, and if such an alarm must also be displayed, the trouble message shall not be displayed until the operator has acknowledged all alarm messages.

C. Short circuit fault isolation: The system shall contain a method of isolating wire-to-wire short circuits on an SLC loop in order to limit the number of detectors or elements that are incapacitated by the short circuit fault. If a wire-to-wire short occurs, the system shall automatically disconnect a down-stream segment of the SLC that contains the short circuit fault. When the short is corrected, the isolated section of the SLC loop shall automatically be reconnected to the SLC and full communication between the control panel and all affected devices restored.

D. Control switch operation: The system control panel shall provide at least the following switches for system control:

1. Acknowledge Switch: Activation of the control panel Acknowledge switch in response to a single new trouble or alarm condition shall silence the panel sounding device and change the System Alarm or Trouble LEDs from flashing to steady-ON. If additional new alarm or trouble conditions exist in the system, activation of this switch shall scroll the display to any queued subsequent alarm or trouble conditions that exist, and shall not silence the local audible device or change the LEDs to steady until all queued conditions have been so acknowledged. New alarm conditions shall always be displayed before new trouble conditions. Activation of the Acknowledge switch shall also cause a corresponding message to be displayed on System displays and Printers.
2. Signal Silence Switch: Activation of the Signal Silence Switch shall cause all appropriate indicating appliance circuits and relays to return to the normal condition after an alarm condition. The selection of indicating appliance circuits silenced by this switch shall be fully programmable from the system control panel. The system shall also include a means through system programming to allow for signal silences inhibit time.
3. System Reset Switch: Activation of the System Reset Switch shall cause all initiating devices, indicating appliance circuits, and associated output devices to return to the normal condition. If alarm conditions exist in the system after the System Reset Switch activation, the system shall then repeat the alarm sequence.
4. Lamp Test Switch: Activation of the Lamp Test Switch shall turn on all LED indicators, system graphic display, and then return all indicators to the previous condition.

6 SERVICE/TESTING AIDS:

A. Automatic detector test: The system shall include a Resident Automatic Detector Sensitivity Test, which satisfy the NFPA and UL requirements for detector sensitivity test. No additional calibrated tests are required if the system indicates the smoke detectors are with in the normal sensitivity range.

B. Watch-dog circuits: The system shall include "Watch-Dog" circuits to detect and report failure of any microprocessor circuit, memory, or software.

C. Field programming: The system shall be totally programmable, configurable and expandable via programming. Systems which require special tools, PROM programmers, or replacement of software media to effect permanent program changes will not be accepted. All programs shall be stored in non-volatile memory. The programming function shall be accessed via a special password, which shall be selected when the system is installed. The password shall be changeable in the field at any time by entering the old password and requesting a password change. All software shall be supplied with the system so that the Owner may fully program and maintain the system.

7 FIRE ALARM SYSTEM OPERATORS' INTERFACE:

A. The system display: The display shall provide the means to inform the System Operator with detailed information about the off-normal status of the installed Fire Alarm System. The LCD display shall automatically respond to the status of the system, and shall display that status in 80-character front panel display.

B. Automatic functions: The following status functions shall be annunciated by the LCD Display:

1. When the Fire Alarm System is in the "Normal" Mode, the panel displays:
   a. The current Date and Time.
   b. A Custom System Title (minimum 2 lines X 21 characters).
   c. A summary total of system events.
2. With the Fire Alarm System in the "Alarm" Mode, the display shall automatically reconfigure into four logical windows.
   a. Systems Status Window: The DISPLAY shall show the system time and the number of active points and disabled points in the system in this section of the DISPLAY.
   b. Current Event Window: The DISPLAY shall show the first active event of the highest priority in reverse text to highlight the condition to the Emergency Operator. The top line of the reversed text shall show the sequence number in which the displayed event was received, as well as its event type. The second and third lines of reversed text shall display an identification message related to the displayed event.
   c. Last Event Window: The DISPLAY shall show the most recent, highest priority event received by the system.
   d. Type Status Window: The DISPLAY shall show the total number of active events in the system, by event type. There shall be four different System Event Types which shall be displayed, "Alarm Events", "Supervisory Events", "Active Trouble Events", and "Active Monitor Events".

8 System protected premises circuit interface: An Electronic Loop Controller (SLC) shall be provided in each Fire Alarm Control Panel (where needed), to interface between the panel and the Analytical Microprocessor-based Detectors and modules. On each electronic loop controller in the system there shall be a minimum of 20 spare sensor addresses and 20 spare module addresses for future expansion.

A. The communications format used by this controller shall be 100% digital. Communications between the Fire Alarm Control Panel and the Analytical Microprocessor-based Detectors and modules shall incorporate both BROADCAST POLLING and DIRECT ADDRESS SEARCH (serial polling communication) methods for increased integrity and decreased system response time.

B. The Electronic Loop Controller (SLC) shall communicate to the connected detectors and modules utilising any wiring material or method complying with Chapter 3 of the National Electrical Code (ANSI/NFPA 70-1996). The Electronic Loop Controller shall not require special cables or home run connections to operate. "T" Tapping and parallel wiring shall be permitted on those Signalling Line Circuits designated as Style 4.

C. It shall be possible to connect the electronic loop controller to the Analytical Microprocessor-based Detectors and modules as Style 4 circuits without the use of special shielding, twisted wire, or conduits. It must be possible to wire branch circuits (T-Taps) from Style 4 Circuits. Each Electronic Protection Loop can be configured to operate as a Style 7 loop without the need for additional hardware modules.

D. The electronic controller, through the system program, shall provide the ability to set the sensitivity and alarm verification time of each of the individual Analytical Microprocessor-based Detectors on the circuit. It shall be possible to automatically set the sensitivity of each of the individual intelligent detector for day and night periods.

E. All system programming and history shall be permanently stored in non-volatile memory to ensure that no programming or history is lost. Systems which store initial programming or field programming changes in battery backed memory shall not be accepted.

F. The Electronic Loop Controller shall be capable of addressing all Analytical Microprocessor-based Detectors and modules connected to it electronically, without the need to set switches at any of the individual devices.

G. The Electronic Loop Controller shall provide a minimum of 5 levels of supervision for each smoke detector on the circuit:

1. Device Location
2. Unexpected Device Add/Delete
3. Missing Device Address
4. Changes in the Physical Wiring of the Loop Circuit
5. Changes in Device Personalities

H. The Electronic Loop Controller (SLC) shall detect the electrical location of each connected detector and module. The location and type of each connected device shall be mapped and stored in memory in the loop controller. It shall be possible to access and display this map at any time.

I. The Electronic Loop Controller shall be capable of reporting any additional device addresses, which may have been added to the circuit, and/or changes that may have been made to the wiring in the data circuit. A specific trouble shall be reported for any and all off-normal non-alarm condition.

J. The Electronic Loop Controller (SLC) shall be able to report the following information on a per addressable device basis.

1. Device Address
2. Device Type
3. Current Detector Sensitivity Values and the Extent of Environmental Compensation for smoke detectors.
4. Specific trouble codes to diagnose device / wiring faults.
5. Cumulative Number of Alarms and Troubles.
6. Date of Last Alarm.
7. Alarm Verification Cycle Count.
8. Date of Last Maintenance for the Device.

K. The Electronic Loop Controller shall notify the System Operator when any connected smoke detector reports a “Routine Maintenance Required” signal to the system.

L. If an Electronic Loop Controller should fail to communicate, the circuit shall automatically switch into the stand alone alarm mode. In the stand-alone alarm mode, the circuit shall be capable of producing a loop alarm if any of the connected alarm type intelligent devices become active.

M. To enhance the survivability of the entire installed Fire Alarm System, all Electronic Loop controllers shall be located no more than 1 floor away from the area which they are applied to protect.

9 Hard wired nac circuits: Provide where indicated on the plans supervised hard-wired Notification Appliance Circuits (NAC) for the control of 24Vdc signaling appliances. Each NAC shall operate as a Class B (Style Y) circuit, and shall be capable of controlling up to 3.5 amps of signaling power.

A. Provide where indicated on the plans supervised hard-wired Notification Appliance Circuits (NAC) for the control of 70.7Vrms Audio Signaling Appliances. Each NAC shall operate as a Class B (Style Y) circuit, and shall control up to 35 Watts of signaling power.

B. Provide where indicated on the plans supervised hard-wired Notification Appliance Circuits (NAC) for the control of 25Vrms Audio Signaling Appliances. Each NAC shall operate as a Class B (Style Y), and shall control up to 50 Watts of power to the circuit.

C. Panel NACs shall be power limited to 3.5A at 24Vdc and 4.1A at 20.4Vdc to support higher current demand by visible appliances at lower battery voltages.

10 SYSTEM PROGRAMMABLE OPERATIONS: System Message Processing and Display Operations:

A. The routing of all network annunciation and control parameters shall be configurable to any or all nodes in the network manually, or automatically as a function of the time of day or date.

B. All of the system Printer ports can be configured to display any or all of the following functions:

1. Alarm
2. Supervisory
3. Trouble
4. Monitor
5. Service Group

C. Each Display located anywhere in the system shall be configurable to show the status of any or all of the following functions pertaining to any point anywhere in the entire network system:

1. Alarm
2. Supervisory
3. Trouble
4. Monitor

D. The system shall provide the capability to label each point in the system with up to 256 characters of custom message.

E. The system shall have the capability to provide up to 128 logical “Counting AND” Groups. Each group shall have a programmable ‘activation’ number. Whenever the number of active devices in an AND Group reaches the activation number, the AND Groups’ rules will execute. It shall be possible to ‘overlap’ AND groups by having devices appear in more than one group.

F. The system shall have the ability to define a minimum of 128 Matrix Groups with up to 250 points in each group. For each matrix, it shall be possible to define a ‘radius’ and an ‘activation’ number. The radius number defines the proximity between detector locations. When two detectors activate at or within the value of the ‘radius’ or whenever the number of active devices reaches the activation number the Matrix Group activates. It shall be possible to ‘overlap’ Matrix groups by having devices appear in more than one group.

G. The system shall include the ability to define an alternate set of device commands which may be used in combination with the system test command for the testing of the connected Intelligent Smoke Detectors. This function shall disable the normal alarm command for each of the members of the group, so that the testing process will not result in an activation of the building evacuation signals, auxiliary relays or central station connections.

H. The system shall include Time Control functions which will have the ability to control any system output or function, or initiate any system operational sequence as a function of the Month, Day of Week, Date, Hour, Minute, or Holiday.

I. The system shall provide the ability to download data from the intelligent systems Detectors to a P.C. while the system is on-line and operational in the protected premises. The downloaded data may then be analyzed in a diagnostic program supplied by the system manufacturer.

11 FIELD MOUNTED SYSTEM COMPONENTS:

A. Analytical Microprocessor-based Detectors - General Operation The System shall use Analytical Microprocessor-based Detectors that are capable of full digital communications with the Fire Alarm System using both broadcast and polling communications protocols. Each detector shall be capable of performing independent advanced fire detection algorithms. The fire detection algorithm shall measure sensor signal dimensions, time patterns and combines different fire parameters to increase reliability and distinguish real fire conditions from unwanted nuisance alarms caused by environmental events. Signal patterns that are not typical of fires shall be eliminated by digital filters and shall not cause a system alarm condition. Devices not capable of combining different fire parameters or employing digital filters shall not be acceptable.

B. Each smoke detector shall have an integral microprocessor capable of making alarm decisions based on fire parameter information stored in the detectors' memory. Detectors not capable of making independent alarm decisions shall not be acceptable. Maximum total loop response time for detectors changing state (alarm or trouble) shall be 0.5 seconds.

C. Each smoke detector shall have a separate means of displaying system communication and detector alarm status. A green LED shall flash to confirm communication with the system through the electronic loop controller. A red LED shall flash to indicate that the detector is in alarm. If communications between the detector and the electronic loop controller is lost, both LED's will illuminate steady to indicate an alarm in the "standalone mode". Both LEDs shall be visible through a full 360 degree viewing angle.

D. Each smoke detector shall be capable of identifying diagnostic codes to be used for system maintenance. All diagnostic codes shall be stored in the detector.

E. Each smoke detector shall be capable of transmitting pre-alarm and alarm signals to the Fire Alarm Control Panel via the Electronic Loop Controller. It shall be possible to program Fire Alarm Control Panel activity and response to each of the following signal levels:

1. Normal
2. Pre-Alarm
3. Alarm
4. Trouble
5. Detector Need Cleaning

F. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings.

G. Each smoke detector microprocessor shall contain an environmental compensation algorithm, which identifies and sets ambient "Environmental Thresholds" continually and periodically. In this manner, the environmental impact of temperature, humidity, environmental contaminates as well as detector aging shall be automatically monitored. This process shall employ digital compensation techniques to adapt the detector to both long term and short term changes in the environment in which they are installed. The microprocessor shall monitor this environmental compensation value and alert the system operator when the detector 80% of the allowable environmental compensation value. Differential sensing algorithms shall maintain a constant differential between selected detector sensitivity and the derived base line sensitivity that the detector has sensed in its environment. The base line sensitivity information shall be automatically and periodically updated and permanently stored in the detector.

H. The Analytical Microprocessor-based Detectors together with the Electronic Loop Controller shall provide increased system reliability and inherent survivability through intelligent standalone conven-

tional alarm operation. The detectors shall automatically change to standalone conventional device operation in the event of an electronic loop controller communications failure. In the standalone conventional detector mode, the micro-processor-based detector shall continue to operate using sensitivity and environmental compensation information stored in its microprocessor at the time of the communications failure. The electronic loop controller shall continue to monitor the communications loop and activate a loop alarm if any of the connected analytical microprocessor based detectors reach their stored alarm sensitivity threshold.

I. Each detector shall be capable of automatic electronic addressing and/or custom addressing without the use of DIP or rotary switches, and shall mount on a common base to allow the simple replacement of one detector type with another detector type. The addressing of the detectors shall not depend on the electrical position of the detector on the circuit.

12 ANALYTICAL MICROPROCESSOR-BASED DETECTORS - FIXED TEMPERATURE HEAT DETECTOR:

A. The intelligent heat detector shall have a solid-state heat sensor, and shall transmit an alarm at a fixed temperature of 135° F (57°C). The detector shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on its' analysis of the area of installation. The heat detector shall be rated for ceiling installation at a minimum of 70 ft (21.3m) centers and be suitable for wall mount applications

B. Systems using central processing methods to monitor the inputs from a circuit of analog sensors to detect a fire will not be accepted.

13 ANALYTICAL MICROPROCESSOR-BASED DETECTORS - PHOTOELECTRIC SMOKE DETECTOR:

A. The Analytical Microprocessor-based photoelectric detector shall utilize a light scattering type photoelectric smoke sensor to detect visible particulates produced by combustion. The integral microprocessor shall dynamically examine values from the sensor and initiate a system alarm based on the analysis of data. Systems using central intelligence for alarm decisions shall not be acceptable. The detector shall continually monitor any changes in sensitivity due to the environmental affects of dirt, smoke, temperature, aging and humidity. The information shall be stored in the detectors' memory and shall be transferred to the electronic loop controller for retrieval using a laptop PC or the Intelligent Detector Program/Service Tool designed by the manufacturer specifically for the purpose. The photoelectric smoke detector shall be rated for area applications when installed at a minimum of 30 ft (9.1m) centers and shall be suitable for wall mount applications. The photoelectric smoke detector shall be suitable for direct insertion into air ducts up to 3 ft (0.91m) high and 3 ft (0.91m) wide with air velocities up to 5,000 ft/min (0-25.39 m/sec) without requiring specific duct detector housings or sampling tubes.

B. The alarm set point shall be field selectable to any of five sensitivity settings ranging from 1.0% to 3.5% smoke obscuration per foot. The photo detector shall be suitable for operation in the following environment:

1. Temperature: 32°F to 120°F (0°C to 49°C)
2. Humidity: 0-93% RH, non-condensing

3. Elevation: no limit

C. In the event of a loss of communications of the smoke detector with the Electronic Loop Controller, the smoke detector will automatically revert to the "Standalone Conventional" operation, and Fire Alarm System functions shall not be compromised.

14 ANALYTICAL MICROPROCESSOR-BASED DETECTORS - MOUNTING BASES:

A. All Analytical Microprocessor-based Detector mounting bases shall provide a means to mount the detector to a [North American 1-gang, 3½" or 4" octagon box and 4" square box] [European BESA or 1-gang]. The mounting base shall not contain any electronics, shall support all Microprocessor-based Smoke detector types detailed in this specification, and have the following minimum requirements:

1. Removal of the respective detector shall not affect electronic loop communications with other detectors on that loop.
2. Field Wiring Connections shall be made to the room side of the base, so that wiring connections can be made or disconnected by the Contractor without the need to remove the mounting base from the electrical box.
3. The base shall be capable of supporting remote alarm annunciation.

15 ANALYTICAL MICROPROCESSOR-BASED DETECTORS - DUCT SMOKE DETECTION APPLICATIONS:

A. The Analytical Microprocessor-based photoelectric smoke detectors shall be readily adaptable for use directly in air duct smoke detection applications, in ducts 3 ft (0.91m) high and 3 ft (0.91m) wide. When used for duct smoke detection, the smoke detectors shall not forfeit any of the system functionality which they have when used as area smoke detectors.

B. Duct detector housing: The Analytical Microprocessor-based photoelectronic and Multi-Sensor smoke detectors shall be readily adaptable for use in air duct smoke detection applications, using a housing that mounts to the outside of the duct. When used for duct smoke detection, the smoke detectors shall not forfeit any of the system functionality which they have when used as area smoke detectors.

C. The duct smoke detection housing shall allow the detector to sample and compensate for, variations in duct air velocity between 300 and 4000 feet per minute (300 to 1000 for ion-photo-heat detector).

D. Remote alarm LEDs and Remote Test Stations shall be supported by the duct smoke detector.

E. All detectors used in duct applications shall be located in accordance with NFPA 72E recommendations.

16 ANALYTICAL MICROPROCESSOR-BASED DETECTORS – REMOTE ALARM LED.

Provide where indicated on the plans or where the detector is not in sight from the ground, a Remote LED Alarm Indicator for each smoke detector. LED shall have a 180-degree viewing angle and mount on a standard 1-gang box.

17 SINGLE RISER SIGNAL MODULE:

The Microprocessor-based Addressable Single Input Signal Module shall provide one (1) supervised Class B (style Y) Indicating Appliance Circuit capable of a controlling 2A of polarized 24 VDC Notification Appliances, 50W speaker circuit power @ 25VRMS, or 35W speaker circuit power @ 70VRMS.

A. The Microprocessor-based Addressable Single Riser Signal Module shall provide one (1) supervised Style Y Indicating Appliance Circuit (IAC) for the connection of a telephone call-in circuit. The module shall have the capability of generating its own “ring tone” to ensure that the Fire Fighter knows that they are connected to the telephone call-in circuit.

18 CONTROL RELAY MODULE:

A. Microprocessor-based Addressable Control Relay Modules shall provide one form “C” dry relay contact rated at 2 amps @ 24 Vdc to control external appliances or equipment processes. The control relay module shall be rated for pilot duty applications and releasing systems service. The position of the relay contact shall be confirmed by the system firmware. Non-addressable relays will not be allowed.

B. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

C. Secure Egress Door Controls: Provide an output signal using an addressable relay to unlock secured path of egress door devices upon system notification.

B. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
   a. Elevator lobby detectors except the lobby detector on the designated floor.
   b. Smoke detector in elevator machine room.
   c. Smoke detectors in elevator hoistway.
2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
4. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

19 MICROPROCESSOR-BASED ADDRESSABLE MANUAL PULL STATIONS – GENERAL:

The Fire Alarm System shall incorporate microprocessor-based addressable Manual Pull Stations connected over a 2-wire electronic communications loop, using both broadcast and serial polling protocols. All Manual Pull Stations shall display communications and alarm status.

A. All addressing of the Microprocessor-based Addressable Manual Single Action Pull Stations shall be done electronically, and the electrical location of each station shall be automatically reported to the Fire Alarm Control Panel, where it may be downloaded into a PC, or printed out. The addressing of the Manual Pull Station shall not be dependent on their electrical location on the circuit.

B. All Microprocessor-based Addressable Manual Pull Stations shall have a visual means to confirm communications with the FACP, and a visual means to confirm the alarm status of the modules.

C. All field wiring to the Microprocessor-based Addressable Manual Pull Stations shall be supervised for opens and ground faults. All ground faults shall be location annunciated to the module of incidence.

D. Diagnostic circuitry, and their associated indicators, with reviewable Trouble Codes, shall be integral to the Microprocessor-based Addressable Manual Pull Stations to assist in troubleshooting system faults.

E. All Manual Fire Alarm station shall be suitable for operation in the following environment:

1. Temperature: 32°F to 120°F (0°C to 49°C)
2. Humidity: 0-93% RH, non-condensing
3. Include ground fault to the device.

F. Each Manual Pull Station shall have a Stopper II Lexan cover.

20 MICROPROCESSOR-BASED ADDRESSABLE SINGLE ACTION FIRE ALARM STATION:

The Microprocessor-based Addressable Fire Alarm Stations shall be single action fire alarm stations. Provide a key locked test feature. Finish the station in red with white “PULL IN CASE OF FIRE” lettering.

21 FIRE ALARM NOTIFICATION APPLIANCES:

A. Fire alarm notification appliances – general requirements: All appliances which are supplied for the requirements of this specification shall be UL Listed for Fire Protective Service, and shall be capable of providing the “Equivalent Facilitation” which is allowed under the Americans with Disabilities Act Accessibilities Guidelines (ADA(AG)), and shall be UL 1971, and ULC S526 Listed. All appliances shall be of the same manufacturer as the Fire Alarm Control Panel specified to insure absolute compatibility between the appliances and the control panels, and to ensure that the application of the appliances are done in accordance with the single manufacturers’ instructions. Any appliances that do not meet the above requirements, and are submitted for use must show written proof of their compatibility for the purposes intended. Such proof shall be in the form of documentation from all manufacturers which clearly states that their equipment (as submitted) are 100% compatible with each other for the purposes intended. All strobes shall be provided with lens markings oriented for wall mounting. It shall be possible to replace the lens of any installed strobe in order to facilitate the replacement of a broken lens, or to change the orientation of the lens markings. Ceiling mounted strobes shall have lens markings with correctly oriented lettering. Removal of an installed strobe to facilitate the changing of a lens shall not be acceptable.

B. Self - synchronized strobes: Strobes shall be supplied by the same manufacturer as the Fire Alarm Control Equipment. In - Out screw terminals shall be provided for wiring. The Strobes shall have a red or white plastic faceplate. They shall provide the proper candela output for the project and synchronized flash outputs. The strobe shall have lens markings oriented for wall mounting.

C. The same manufacturer as the Fire Alarm Control Equipment shall supply strobes. In - Out screw terminals shall be provided for wiring. The Strobes shall have a red metal faceplate. Provide candela ratings as shown on drawings. All strobes in multi-outlet areas shall be synchronized.

D. Speaker/strobes - electronic type: Horns shall by the same manufacturer as the Fire Alarm Control Equipment. In - Out screw terminals shall be provided for wiring. The Horn shall have a red plastic housing. Horns shall be suitable for indoor or outdoor use. A sound output level of 103 dBA Peak shall be provided. It must not be necessary to completely remove the screws to facilitate mounting.

E. Horn/strobes shall by the same manufacturer as the Fire Alarm Control Equipment. The Horn/Strobes shall have a red plastic housing. Provide candela ratings as shown on drawings. All strobes in multi-outlet areas shall be synchronized. Removal of a installed Horn/Strobe to change the lens markings shall not be acceptable. Horns shall provide a 100 dBA Peak sound output. It must not be necessary to completely remove the screws to facilitate mounting.

22 EXTERIOR HORNS shall be recessed mounted in a red metallic weatherproof cast aluminum box.

23 SYSTEM WIRING:

A. Raceways and outlet boxes: Shall comply with all other applicable Division 26 Specifications. Minimum raceway size for the fire alarm system shall be 1/2". The complete raceway system shall be grounded and bonded in accord with the requirements of the NEC. Outlet boxes shall be installed in the approximate locations indicated on the Drawings. It is the responsibility of the Contractor to ensure that the final locations of fire detectors and other initiating and indicating appliances and devices are in compliance with all applicable codes.

C. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.

1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.
2. Pathways shall be installed in EMT unless within plenum space where plenum rated cabling may be used.
3. Exposed EMT shall be painted red enamel.

C. Conductors and terminations: Shall be copper with type THHN/THWN insulation. Minimum conductor size shall be #14 AWG except that signaling line circuit (SLC) loops shall be wired with UL listed type FPL cable comprised of a jacketed and electrically shielded pair of conductors #18 AWG or larger. If stranded conductors are used they shall comply with Sections 760-16(c), 760-28(a), and 760-30(a) of the NEC.

D. All circuits shall be identified using a unique conductor insulation color throughout the system for each type of circuit.

E. Termination of conductors shall be by means of factory wiring terminals or factory pigtails.

24 CIRCUIT PROTECTORS:

Shall have a line-to-line response time of less than one nanosecond capable of accepting greater than 2000 amps at 28 volts. Line-to-earth response time shall be less than one nanosecond with a maximum current of 2000 amps (35 joules each line) to earth. Shield to earth current shall be 5000

amps maximum. Spark gap devices or devices incorporated in or installed within the fire alarm control panel in lieu of the specified protector are not acceptable.

25 Networked Fire Alarm System

25.2.1 Network fire alarm control units shall include all features as described in this specification for stand-alone FACUs and shall have network communication capabilities as described herein.

25.2.1.1 All points monitored and controlled by a single node shall be capable of being programmed as “Public”. Each point made public to the network may be programmed to be operated by any other node connected to the network.

25.2.1.2 Network communications shall be capable of supporting “point lists” that can be handled as though they were a single point.

25.2.1.3 The network shall provide a means to log into any node on the system via a laptop computer and have complete network access (Set Host) for diagnostics, maintenance reporting, and information gathering of all nodes in the system. [The means shall include the capability to log into any node on the system via TCP/IP Ethernet network communications protocol compatible with IEEE Standard 802.3. Ethernet access to any fire alarm panel shall be capable of providing access only to authenticated users through a cryptographically authenticated and secure SSL tunnel. Provisions for a standard RJ-45 Ethernet connection to the owner’s Ethernet network must be provided at each node as part of the contract. Systems not meeting this requirement must provide all diagnostic tools required to support this function from selected points on the network. This Section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.

25.2.1.4 Network node communication shall be through a token ring, hub, or star topology configuration, or combination thereof.

25.2.1.5 A single open, ground or short on the network communication loop shall not degrade network communications. Token shall be passed in opposite direction to maintain communications throughout all network nodes. At the same time the status of the communication link shall be reported.

25.2.1.6 If a group of nodes becomes isolated from the rest of the network due to multiple fault conditions, that group shall automatically form a sub-network with all common interaction of monitoring and control remaining intact. The network shall be notified with the exact details of the lost communications.

25.2.1.7 Fiber optics communication shall be provided as an option via a fiber optics modem. Modem shall multiplex audio signals and digital communication via full duplex transmission over a single fiber optic cable, either single mode or multi mode.

25.2.1.8 The communication method shall be NFPA 72 style 7.”

## PART 3 - EXECUTION

3.1 The entire system shall be installed in a workmanlike manner in accordance with approved manufacturers manuals and wiring diagrams. The Contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation. All wiring shall be of the type recommended by the NEC, approved by local authorities having jurisdiction for the purpose, and shall be installed in dedicated conduit throughout.

3.2 All penetration of floor slabs and fire walls shall be fire stopped in accordance with all local fire codes. In addition, all walls shall be water-proofed at conduit penetrations.

3.3 END OF LINE RESISTORS:

Shall be furnished as required for mounting as directed by the manufacturer.

3.4 INSTALLATION OF CONTROL PANEL AND RELATED EQUIPMENT:

A. Installation of all Fire Alarm Control Equipment and Field Mounted Devices and Appliances shall be in strict compliance with the manufacturer's written instructions.

B. Connection of the fire alarm system power supply (supplies) to the electrical system shall be by a dedicated branch electrical circuit. The means to disconnect this circuit shall be accessible only to authorized personnel, shall be capable of being locked in the "on" position, and shall be clearly marked "FIRE ALARM CIRCUIT CONTROL" in accord with NFPA standards.

C. Batteries shall only be installed in the control panel enclosure when they are of the gelled-electrolyte type and where the control panel manufacturer recommends such installation.

D. The Control Equipment shall not be installed until all field wiring to the field mounted devices and appliances have been installed and the wiring on those circuits have been checked for faults and shorts, and any faults and shorts found have been corrected.

E. The Fire Alarm Contractor shall neatly lace all field wiring conductors in the gutter spaces of the control panels and secure the wiring away from all circuit boards and control equipment components. All field-wiring circuits shall be neatly and legibly labeled in the control panel. No wiring except homeruns from fire alarm system circuits and system power supply circuits shall be permitted in the control panel enclosure. Additionally, no wiring splices will be permitted in the control panel enclosure.

3.5 SYSTEM WIRING AND SUPERVISION:

A. Provide a Style 7 initiating and alarm circuits with electrical supervision for shorts and open conditions.

B. Install end-of-line resistors as required.

C. Power Supplies: The control panel shall receive 120 VAC power via the existing power supply for the current fire alarm control panel, unless otherwise shown.

D. All circuits requiring system operating power shall be 24 VDC and shall be individually fused at the control panel.

E. Control of auxiliary services:

1. Fan shut down relays. Only addressable control relays will be allowed.
2. Alarm initiation from kitchen extinguishing equipment.

F. Equip and wire system so that by energizing fire alarm audible signaling devices will also activate the following:

1. Interior strobe lights.
2. Fan shut-down circuits.
3. Release kitchen fire rated shutter after a 15 second time delay. Time delay shall be adjustable from 0 to 60 seconds.
4. Closing of the main gas service valve.

3.6 SYSTEM TEST AND CERTIFICATION / DEMONSTRATION:

The completely installed fire alarm system will be fully tested in compliance with Testing Procedures for Signaling Systems (ANSI/NFPA 72H). The Fire Alarm Contractor shall test:

A. Every alarm initiating appliance and device for proper response and program execution.

B. Every indicating appliance for proper operation and audible/visual output

C. All auxiliary control functions such as elevator capture, smoke door and damper release, and functional override of HVAC, ventilation, and pressurization controls.

3.7 The Architect shall be notified at least 10 working days prior to the scheduled testing so that he/she may be present for such testing. The testing will only be scheduled after "As-Built" Drawings are turned in with the Affidavit of True and Correct As-Built Drawings fully executed. Find blank affidavit at the end of this section.

A. After the system has been completely tested to the satisfaction of the Architect, and the building Owner; the Fire Alarm Contractor shall complete the Fire Alarm System Certification of Completion form published by the NFPA (Figure 1-7.2.1 in the National Fire Alarm Code). In compliance with published NFPA standards, parts 1, 2, and 4 through 10 shall be completed after the system is installed and the wiring has been checked. Part 3 shall be completed after the operational acceptance tests have been completed. The completed form signed by the qualifying agent of the Fire Alarm System Contractor shall be delivered to the Architect with the other system documentation required by these specifications.

3.8 DELIVERY OF SYSTEM DOCUMENTATION PACKAGE:

The Fire Alarm Contractor shall deliver two sets of the System Documentation Package to the Building Owners Representative and the Local Authority Having Jurisdiction. Final payment of the Contractor will not be authorized until the complete documentation specified herein is delivered to the Architect. The System Documentation Package shall consist of the following documents, to be provided after the fire alarm system has been completely installed and tested:

A. Operations and Maintenance Manuals which detail the operation and maintenance of the installed System. An "As-Built" copy of the scaled plan of each building showing the actual installed location of each piece of fire alarm equipment as well as the installed raceway sizes and routing, conductor sizes and quantities in each raceway, and the exact location of each junction box. The Affidavit of True and Correct As-Built Drawings shall be fully executed and turned in with "As-Built" drawings (as shown at the end of this section).

B. Point to Point diagrams of the entire System as installed and tested. Point to Point Diagrams shall include all connected Smoke and Heat Detectors and addressable Field Modules. In addition, "As-Built" riser and wiring diagrams reflecting all T-Taps, each programmed device characteristic including detector type, base type, serial number, sensitivity setting and wire configurations will be provided to the Architect, based on the information gathered during the system final testing process.

C. All "As-Built" drawings and diagrams shall be done and turned over to the Owner.

D. The application program (database) listing for the system as installed at the time of acceptance by the building Owner and/or Local AHJ (Disk and Hard copy printout).

E. Time and Date stamped report, which lists every Fire Alarm System Cabinet within the system. This report shall include date regarding each cabinet in the system, the hardware modules mounted in each cabinet, and the physical mounting location of each module.

F. A Time and Date stamped report, which lists every detector, module, switch and output circuit within the system. This report shall include addressing, custom labeling, device type, and physical location for each device.

G. A letter certifying that the installation is in strict compliance with all applicable codes and in strict compliance with the requirements of these specifications.

H. Two originals of the NFPA document titled “Fire Alarm System Certification and Description” completely filled-in and signed as required.

I. Name, address, and telephone of the authorized factory representative.

J. Written certification by the fire alarm Contractor that no power supply audio amplifier or circuit on the system has an electrical load greater than 80% of its rated capacity.

K. Copies of the manufacturers’ 3-year warranty on all the system components and the Contractors’ 3-year warranty on the installed system.

3.9 SYSTEM STARTUP:

A Factory Trained and Authorized Engineered Systems Distributor shall perform system Startup. A Contractor under the direction of the Factory Trained and Authorized Engineered Systems Distributor may perform certain functions of the Systems Startup Procedure.

3.10 INSTRUCTION OF OWNER:

The Fire Alarm Contractor shall schedule and execute an instruction class for the Building Owner, which details the proper operation of the installed fire alarm system. The instruction shall also cover the schedule of maintenance required by NFPA 72H and any additional maintenance recommended by the system manufacturer. This instruction shall also be separately furnished to the Local Municipal Fire Department if so requested by the Local Authority Having Jurisdiction. The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation. The Fire Alarm Contractor shall provide operations manuals or any other curricula that may enhance the instruction of the Building Owners or Local Municipal Fire Department in the operation and maintenance of the system.

3.11 WIRING:

A. All wiring shall be installed according to NEC standards per the drawings submitted by the authorized Engineered Systems Distributor, unless otherwise noted.

B. Where required, wiring shall be in metallic conduit solely for the fire detection and alarm system. Minimum conductor size shall be #14 AWG. Install and connect wiring in conformance with the recommendations and wiring diagrams provided by the Fire Alarm System manufacturer. Adhere to the zones indicated on the Drawings. Any non-metallic conduit shall be replaced with metallic conduit with no cost to the Owner.

C. All wiring shall be tagged, numbered, color-coded and terminated on terminal blocks in the cabinets, in boxes, at equipment and at devices. Wire nuts or splices shall not be used. Each set of zone conductors shall be tagged with the zone number on each conductor at termination (each end) and in each junction or pull box in the raceway system.

3.12 Mounting of fire alarm boxes shall be 48" above finished floor (Handicapped Code).

3.13 Junction boxes and cabinets for the Fire Alarm System shall be painted International "FIRE RED".

3.14 FIELD QUALITY CONTROL:

The system shall be installed and fully tested under the supervision of trained manufacturer's representative. The system shall be demonstrated to perform all the functions as specified.

3.15 Provide in a frame and under glass, computer generated, color-coded diagram of the building and site, indicating the zones by number. Install frame near the fire alarm control panel or the annunciator panel or at a location designated by the Owner's representative. Minimum size of the graphic shall be 11"x17".

3.16 TESTS:

Upon completion of the installation, the Contractor and the manufacturer's authorized representative together shall test every alarm initiating device for proper response and zone indication, every alarm signaling device for effectiveness, and all auxiliary functions. Repeat all tests with "NORMAL" power disconnected. The Owner and designated representative shall be given the opportunity to witness these tests. An itemized test report shall be submitted to the Owner, detailing and certifying all results.

3.17 WARRANTIES:

The Contractor shall warrant the complete fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of 3 years specified herein from the date of placing the completed system in operation. The conductors shall be replaced on any loop that exhibits repeated ground faults. If the ground faults persist, each device on that loop shall be replaced. These repairs are to be considered warranty work and shall be performed at no additional cost to the Owner.

3.18 The equipment manufacturer shall make available to the Owner a maintenance contract proposal to provide a minimum of 2 inspections and tests per year in compliance with NFPA-72 guidelines.

3.19 The maintenance contract shall include an agreement by the manufacturer that it will provide to the Owner, verifiable evidence to substantiate its claim that damage to any part of the fire alarm system was caused by lightning. Such evidence shall include, but not limited to, proof that the surge entered the equipment either on power conductors, system ground or by communication lines. Proof that the surge was not related to switching, welding, motor starting, copy machines or equipment with silicon-controlled rectifiers such as battery chargers and un-interruptible power systems.

3.20 Furnish 3 bound copies of brochure including maintenance instructions, spare parts list, wiring diagram and troubleshooting check list.

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# SECTION 30 00 00
# GENERAL SITE WORK REQUIREMENTS

## 1. GENERAL

### 1.1 DESCRIPTION OF WORK
A. Includes but not limited to general procedures and requirements for site work.

### 1.2 INTENT
A. It is intent of Division 30 to provide supplemental information to contents of construction drawings on quality of materials, execution, measurement, etc. Sections are general in nature and may contain products and requirements for indeterminate conditions. Materials and products to be as shown on construction drawings. When specific material or product not shown on construction drawings, select from materials and products contained in specifications.
   1) Discrepancies between specifications and plans shall be brought to attention of Engineer for clarification. When discrepancies exist between selection of materials, execution, measurements, etc., most stringent condition to control unless directed otherwise by Engineer.
   2) Work of Division 30, including construction drawings, is intended to be consistent with the work of others. Notify Engineer of discrepancies or conflicts. Most stringent condition to control unless directed otherwise by Engineer.

### 1.3 RELATED SECTIONS
A. Division 30 sections.

### 1.4 ELEVATION REFERENCES
A. All elevations refer to the project elevation datum as shown on construction drawings.
   1) Vertical layout to be performed using the provided site benchmarks. In no case shall any other benchmark or elevation reference be used in construction of the project. Contractor shall not utilize elevations of existing improvements shown in the construction drawings or from other sources as a basis of construction. Failure to comply with these requirements may result in removal and replacement of improvements at no cost to Owner.
   2) In the event that benchmarks are disturbed or destroyed during construction, Contractor shall notify Surveyor for repair or replacement. Use of the provided benchmarks for vertical control should be performed in accordance with standard surveying techniques and the minimum technical standards for surveying in the State of Florida, FAC 5J-17. Prior to utilizing the benchmarks for vertical layout, Contractor shall check between a minimum of two provided benchmarks to insure their integrity.

B. Spot elevations shown on plans are to top of improvement or ground surface unless noted otherwise. Finished subgrade elevation beneath proposed improvement to be determined by deducting from shown elevation the improvement thickness in accordance with improvement details. Spot elevations furnished are sufficient to define the elevation for all improvements. Specific elevations for all improvements may not be shown when such improvement elevations may be determined based on the elevation of adjacent improvements, i.e. elevation of curb adjacent to pavement may not be shown and curb elevation is determined by adding curb height from details to pavement elevation.

C. Building slab elevation shown on plans is ground, base floor slab elevation excluding steps or recesses unless specifically dimensioned. Add or subtract to base floor elevation to achieve finished floor elevation. Refer to architectural plans for steps and recesses in slab. Finished subgrade elevation beneath proposed building slab and foundations to be determined by deducting from shown base floor slab elevation the slab thickness in accordance with building plans.

## 1.5 SPECIFICATION REFERENCES

A. All specifications and documents referenced to be of latest issue and to be considered a part of documents as though included. Terminology ***FDOT Section XXX*** references Florida Department of Transportation (FDOT) ***Standard Specifications for Road and Bridge Construction.*** Terminology ***FDOT Index No. XXX*** references FDOT ***Roadway and Traffic Design Standards.*** Terminology ***MUTCD XXX*** references Federal Highway Administration ***Manual on Uniform Traffic Control Devices, Sign No. XXX.*** Unless noted or directed otherwise, Contractor shall comply with recommendations in standard specifications as though they were requirements.

## 1.6 SUBMITTALS

A. Product Data: Submit 5 copies of product data, stamped approved by Contractor, on all applicable manufactured items including but not limited to:
   1) Castings.
   2) Control panel components.
   3) Erosion control products.
   4) Pipe and appurtenances.
   5) Pumps and appurtenances.
   6) Traffic Paint.
   7) Seed mix.

B. Shop Drawings: Submit 5 copies of shop drawings, stamped approved by Contractor, on all applicable constructed items including but not limited to:
   1) Pre-cast concrete structures.
   2) Control panels.
   3) Hatches and frames.
   4) Skimmers.

C. Operating Manuals: Submit 3 copies of a manual containing installation instructions, operating instructions, wiring diagrams, parts lists, and where applicable test data and pump curves for all pumping stations.

D. Quality Assurance Submittals: Submit following applicable reports directly to Engineer from testing services with copy to Owner, Contractor, and municipality or third party when item will be dedicated:
   1) Suitable fill and backfill material.
      (a) Maximum density/Optimum moisture content.
      (b) Field density and thickness.
      (c) Gradation
   2) Stabilization material.
      (a) Bearing Test (LBR)
   3) Base Material:
      (a) Bearing Test (LBR)
      (b) Optimum Moisture - Maximum Density
      (c) Gradation and Atterberg Limits
      (d) Field Density and Thickness
   4) Base Material (Asphalt Base Course):
      (a) Mix Design
      (b) Field Thickness
      (c) Aggregate Certificate
   5) Asphalt Surface Course:
      (a) Mix Design
      (b) Field Thickness
      (c) Aggregate Certificate
   6) Pavement Markings:
      (a) Material certification or
      (b) Manufacturer's literature
   7) Asphalt mix design.
   8) Concrete mix design.
   9) Filter material certified gradation test or letter.

10) Bacteriological Test Reports. Bacteriological testing must be performed concurrent to the as-built survey of the water system. If the as-built survey is delayed, bacteriological testing must be repeated at the time of the as-built survey for use in certification of the system. Bacteriological tests older than 60 days are not valid for use in system certification.
11) As-Built Survey in accordance with item 3.9 contained herein.

E. Approvals: Items requiring approval prior to installation to be submitted directly to Engineer with copy to Owner, Contractor, and municipality or third party when item will be dedicated a minimum of two weeks prior to installation.

## 1.7 QUALITY ASSURANCE

A. Testing and Inspection: Testing service will be engaged by Owner or Contractor, as specified in Contract Clauses, for quality control testing. Contractor to provide initial testing of materials for conformance to specifications.
   1) For projects involving improvements to be dedicated to a municipality or third party, additional testing or testing by special parties may be required. Verify testing and inspection requirements.
   2) For improvements within public right of ways and certain utility improvements, the right of way or utility Owner may have additional testing and inspection requirements. Verify testing and inspection requirements.
   3) Provide to Owner, Engineer, testing service, and municipality or third party a list of tests, inspections and associated party responsible for performing test or inspection.
   4) Coordinate all testing and inspections.
   5) Notify Engineer, testing service, municipality of third party and applicable agency inspectors 48 hours in advance of testing and inspections.

B. Guarantee: Neither the final certificate of payment nor any provisions in the contract documents nor partial or entire use or occupancy of the premises by the Owner shall constitute an acceptance of work not done in accordance with the contract documents or relieve the Contractor of liability in respect to any express warranties or responsibility for faulty materials or workmanship. The Contractor shall remedy any defects in work and pay for any damage to other work resulting therefrom which shall appear within a period of one year from the date of final acceptance of the work unless a longer period is specified. The Owner will give notice of observed defects with reasonable promptness. When applicable, the Contractor's Performance or Contract Bond shall remain in effect and cover this guarantee.

## 1.8 PROJECT CONDITIONS

A. Improvements on Adjoining Property (when applicable)
   1) Authority for performing work on property adjoining project site will be obtained by Owner prior to award of contract. Contractor to obtain copy of authorization prior to beginning work.
   2) Do not enter upon private property without permission of Owner or Lessee.
   3) Extent of work on adjacent property is indicated on Drawings.

## 1.9 UNDERGROUND FACILITIES

A. Plans show certain Underground Facilities, but do not purport to show in complete detail all such facilities or obstructions. Information shown was provided by others, obtained from available records and/or field locations of visible items, and is provided for convenience. Neither Owner, nor Engineer is responsible for accuracy or completeness of any such information or data.
B. Coordinate and obtain locates from utility Owners including potential utility Owners.
C. Obtain and review all known sources of information and records on utilities within area.
D. Locate vertically and horizontally all Underground Facilities marked, indicated, reported, or known, with sufficient accuracy to complete work or identify conflicts without damage to utility.
E. Notify Engineer when marked, indicated, reported or known utilities cannot be located. Do not perform work in any area with known but unfound utilities without authorization in writing by Engineer. Include following in notification:
   1) Type and size of utility.
   2) Subject area.
   3) Efforts made to determine location of item.

F. If an Underground Facility is uncovered or revealed which, in opinion of Contractor, results in a conflict which was not included in Construction Documents, promptly give written notice to facility owner, Owner, and Engineer and stop work before further disturbing conditions until such time as a determination is made on how to proceed. Engineer shall review Underground Facility and determine extent, if any, to which a change in Contract Documents is required. If Engineer determines that a change is required, then Engineer shall request a price from Contractor for change and issue a Change Order upon acceptance by Owner.
G. Coordinate Work with Owners of Underground Facilities during construction time period.
H. Protect all Underground Facilities.
I. Repair or replace Underground Facilities at no cost except for following:
   1) Damage to utilities of which Contractor had no knowledge and could not reasonably have been expected to have knowledge.
   2) Damage to utilities of which Contractor had knowledge, but was unable to accurately locate horizontally or vertically, and properly notified Engineer, and obtained Engineer's authorization to proceed.

## 2. PRODUCTS - NOT USED

## 3. EXECUTION

### 3.1 CONSTRUCTION LAYOUT SURVEY

A. Set construction stakes to mark location, alignment, elevation and grade of work. Stakes to be adequate in number, position and elevation so physical item can be constructed in accordance with plans. Construction layout survey to meet Florida minimum technical standards for land surveying (Chapter 5J-17, FAC), and to be performed by a person of adequate expertise. Failure to perform construction stakeout in accordance with construction plans may result in removal and replacement of improvements at no cost to Owner. Construction layout information is provided in form of dimensions and offsets and/or coordinates obtained through computer generation. Information is adequate for construction layout of improvements using standard surveying construction layout techniques. Do not scale information from plans or attempt to construct improvements without performing construction layout in accordance with information contained herein.

### 3.2 REMOVAL OF STRUCTURES AND OBSTRUCTIONS

A. Remove any existing above or below ground structure, structure part, fence, building or other encumbrance or obstruction upon or within limits of work and shown for removal, which interferes in any way with new construction.
B. Remove any abandoned below ground structure or utility within limits of work and shown for removal, which interferes in any way with new construction.
C. Do not remove any existing above or below ground structure when not shown in the work for removal without authorization.

### 3.3 PUBLIC CONVENIENCE AND SAFETY

A. It is sole responsibility of Contractor to comply and enforce all applicable safety regulations. Provide all necessary signage and markings to insure a safe site. Signage and marking adjacent to and within roadways to be in accordance with FDOT Section 102, FDOT Manual on Traffic Control and Safe Practices and FDOT Roadway and Traffic Design Standards.

### 3.4 DISTURBED AREAS

A. Restore areas disturbed by direct or indirect construction activities to a condition equal to condition prior to construction activities. When grassed areas are restored, type and method to be in accordance with Section 31 25 00.

### 3.5 SALVAGEABLE IMPROVEMENTS

A. Carefully remove items indicated to be salvaged, and store or remove at direction of Owner.

## 3.6 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Removal from Owner's Property: Unless directed otherwise, remove excess and/or waste materials, unsuitable and/or excess soils from Owner's property and dispose of off-site in legal manner. At option of Owner, retain suitable excess soils on-site.
B. Burning on Owner's Property: Burning is not permitted on Owner's property unless authorized in writing by Owner.
   1) Perform burning in accordance with applicable rules and regulations and obtain necessary permits.
   2) Remove waste materials remaining after burning operations off-site and dispose of in accordance with applicable regulations. In no case shall ashes remain within limits of property.
C. Removal to Designated Areas on Owner's Property: If so directed, transport excess and/or waste materials and/or unsuitable and excess soils to designated storage areas on Owner's property. Stockpile or spread as directed by Engineer.
D. Burial on Owners Property: Burial of waste material is not allowed.

## 3.7 TESTING REQUIREMENTS

A. General: Conduct testing in accordance with following. Allow testing service to inspect and approve work before further construction is performed. Testing requirements may be contained in geotechnical report or on plans. In event of a discrepancy, most stringent condition shall apply unless directed otherwise by Engineer. Tests, which must be repeated due to unsatisfactory results, will be at no additional cost to Owner. Testing to be in accordance with following standards.
   1) Limerock Bearing Ratio (LBR): FDOT LBR Method (FM 5-515).
   2) Maximum Density/Optimum Moisture Content: AASHTO T-180/ASTM D-1557.
   3) Field Density and Thickness: AASHTO T-191/ASTM D-1556 (sand cone method) or AASHTO T-204/ASTM D-2937 (drive cylinder method).
   4) Gradation: AASHTO M-92/ASTM D-422.
B. Pavement Sub-Grade/Sub-Base:
   1) Bearing Value: Perform one LBR test for each material source or as material changes.
   2) Maximum Density/Optimum Moisture Content: Perform one test for each soil type.
   3) Field Density and Thickness: Perform 1 test and thickness measurement for each 500 linear feet of roadway or 750 square yards of pavement with not less than three tests.
C. Fill and Backfill under Pavement and Site Structures:
   1) Maximum Density/Optimum Moisture Content: Perform one test for each soil type.
   2) Field Density and Thickness: Perform one test and thickness measurement for each 500 linear feet of roadway or 750 square yards of pavement with not less than three tests on alternating lifts (12 inch maximum thickness unless specified otherwise).
   3) Gradation: Perform 1 gradation test for each soil type.
D. Utility Trench Fill and Backfill:
   1) Maximum Density/Optimum Moisture Content: Perform one test.
   2) Field Density and Thickness: Perform 1 test and thickness measurement for each 500 linear feet of trench with not less than three tests on alternating lifts (12 inch maximum thickness unless specified otherwise).
   3) Gradation: Perform 1 gradation test for each soil type.
E. Fill and Backfill under Building Areas: Coordinate with building plans/specifications and Geotechnical Engineer. Unless directed otherwise, prove at a minimum the following.
   1) Maximum Density/Optimum Moisture Content: Perform one test for each soil type.
   2) Field Density and Thickness: Perform 1 test and thickness measurement per 2000 sf of floor area, per 3 isolated column footings and per 50 lineal feet of wall footing.
   3) Gradation: Perform 1 gradation test for each soil type.
F. Sanitary Sewer Systems:

1) Line Deflection Test: Perform deflection testing in presence of Engineer, and if required utility provider, using either 95% diameter mandrel or ball testing in accordance with ASTM D3034 and Section 33.85 of the GLUMRB Recommended Standards for Wastewater Facilities. Deflection not to exceed 5%. Perform such supplemental deflection testing as required by utility provider. Perform utility provider required testing in presence of Engineer and utility provider. Utility provider supplemental test method may be visual testing by "flashing", alignment logging videography, a combination of methods, or other method as determined by utility provider. Coordinate requirements with utility provider.
2) Line Leakage: Test lines for leakage as soon as practical. Engineer to observe test.
   (a) Test to be by low-pressure air test in accordance with ASTM C-828 for clay pipe, ASTM C-924 for concrete pipe, and ASTM F-1417 for plastic pipe. Refer to UNI-Bell Recommended Practice for Low-Pressure Air Testing, UNI-B-6. Consult with pipe and appurtenance manufacturer for maximum test pressure for pipe size greater than 30-inches in diameter. Plastic pipe pressure drop limits in accordance with ASTM F-1417 Table 1 as follows.

ASTM F-1417 Table 1 Minimum Specified Time Required for a 1.0 psig Pressure Drop for Size and Length of Pipe Indicated for Q = 0.0015

| Pipe Dia., In. | Minimum Time, Min.:Sec. | Length for Minimum Time, Ft. | Time for Longer Length, Sec. | Specification Time for Length (L) Shown Min:Sec 100 Ft. | 150 Ft. | 200 Ft. | 250 Ft. | 300 Ft. | 350 Ft. | 400 Ft. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 3:46 | 597 | 0.380 L | 3:46 | 3:46 | 3:46 | 3:46 | 3:46 | 3:46 | 3:46 |
| 6 | 5:40 | 398 | 0.854 L | 5:40 | 5:40 | 5:40 | 5:40 | 5:40 | 5:40 | 5:42 |
| 8 | 7:34 | 298 | 1.520 L | 7:34 | 7:34 | 7:34 | 7:34 | 7:36 | 8:52 | 10:08 |
| 10 | 9:26 | 239 | 2.374 L | 9:26 | 9:26 | 9:26 | 9:53 | 11:52 | 13:51 | 15:49 |
| 12 | 11:20 | 199 | 3.418 L | 11:20 | 11:20 | 11:24 | 14:15 | 17:05 | 19:56 | 22:47 |
| 15 | 14:10 | 159 | 5.342 L | 14:10 | 14:10 | 17:48 | 22:15 | 26:42 | 31:09 | 35:36 |
| 18 | 17:00 | 133 | 7.692 L | 17:00 | 19:13 | 25:38 | 32:03 | 38:27 | 44:52 | 51:16 |
| 21 | 19:50 | 114 | 10.470 L | 19:50 | 26:10 | 34:54 | 43:37 | 52:21 | 61:00 | 69:48 |
| 24 | 22:40 | 99 | 13.674 L | 22:47 | 34:11 | 45:34 | 56:58 | 68:22 | 79:46 | 91:10 |
| 27 | 25:30 | 88 | 17.306 L | 28:51 | 43:16 | 57:41 | 72:07 | 86:32 | 100:57 | 115:22 |
| 30 | 28:20 | 80 | 21.366 L | 35:37 | 53:25 | 71:13 | 89:02 | 106:50 | 124:38 | 142:26 |
| 33 | 31:10 | 72 | 25.852 L | 43:05 | 64:38 | 86:10 | 107:43 | 129:16 | 150:43 | 172:21 |
| 36 | 34:00 | 66 | 30.768 L | 51:17 | 76:55 | 102:34 | 128:12 | 153:50 | 179:29 | 205:07 |

   (b) Low pressure air testing procedures for other pipe materials to use the pressures and testing times as contained in ASTM C-828 and ASTM C-924 and as determined by pipe manufacturer and approved by Engineer.
   (c) Provide appropriate plugs or end caps, properly braced and capable of withstanding test pressures, at service connections.
3) Manhole Leakage: Test manholes for leakage as soon as practical. Engineer to observe test.
   (a) Test to be by low-pressure air test in accordance with ASTM C-1244.
   (b) Provide appropriate plugs capable of withstanding test pressures at pipe connections with manhole.
   (c) In accordance with ASTM C-1244, test head to be placed at top of manhole in accordance with manufacturer's recommendations.
   (d) Conduct test by placing a vacuum of 10 inches Hg on manhole, close valve on vacuum line of test head, and shut off vacuum pump. Measure time for vacuum to drop to 9 inches Hg. Time shall not exceed the value contained in ASTM C-1244 Table 1, contained below. If test fails, correct as required and retest.

ASTM C-1244 Table 1 Minimum Test Times for Various Manhole Diameters in Seconds

| Depth (Ft) | Diameter, In. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 30 | 33 | 36 | 42 | 48 | 54 | 60 | 66 | 72 |
| | Time, Seconds | | | | | | | | |
| 8 | 11 | 12 | 14 | 17 | 20 | 23 | 26 | 29 | 33 |
| 10 | 14 | 15 | 18 | 21 | 25 | 29 | 33 | 36 | 41 |
| 12 | 17 | 18 | 21 | 25 | 30 | 35 | 39 | 43 | 49 |
| 14 | 20 | 21 | 25 | 30 | 35 | 41 | 46 | 51 | 57 |
| 16 | 22 | 24 | 39 | 34 | 40 | 46 | 52 | 58 | 67 |
| 18 | 25 | 27 | 32 | 38 | 45 | 52 | 59 | 65 | 73 |
| 20 | 28 | 30 | 35 | 42 | 50 | 53 | 65 | 72 | 81 |
| 22 | 31 | 33 | 39 | 46 | 55 | 64 | 72 | 79 | 89 |
| 24 | 33 | 36 | 42 | 51 | 59 | 64 | 78 | 87 | 97 |
| 26 | 36 | 39 | 46 | 55 | 64 | 75 | 85 | 94 | 105 |
| 28 | 39 | 42 | 49 | 59 | 69 | 81 | 91 | 101 | 113 |
| 30 | 42 | 45 | 53 | 63 | 74 | 87 | 98 | 108 | 121 |

4) Storm Sewer Systems:
   (a) For systems or portions of systems to be dedicated to a municipality or third party, perform tests in accordance with entity requirements.
   (b) When requested, perform line deflection test and/or line leakage test in accordance with requirements for sanitary sewer systems.

**3.8 INSPECTION REQUIREMENTS**

A. General: Following items will be inspected by Engineer upon completion. Contractor to schedule inspections.
   1) Improvements to be dedicated to a municipality or third party may require additional inspections by special parties. Verify inspection requirements with municipality or third party and schedule inspections. Prior to final acceptance, Contractor shall schedule inspection with Engineer and municipality or third party.

B. Graded Areas: Prior to placement of permanent vegetative stabilization, graded areas will be inspected by Engineer.

C. Pavement Areas: Pavement and striping to be inspected by Engineer and Geotechnical Engineer upon completion.

D. Permanent Erosion Control Systems: Upon completion and end of maintenance period for vegetative systems, systems will be inspected by Engineer.

E. Utility Systems: Underground utility work of Division 30 will be subject to a visual inspection by Engineer prior to covering and upon completion of construction.
   1) Prior to final inspection, remove all sediment from structures and pipe and dispose of in an appropriate manner.

F. Sanitary Sewer Systems: Engineer will inspect upon completion.
   1) Videography: When required, provide video of sanitary sewer main in accordance with utility requirements.

G. Storm Sewer Systems: Engineer will inspect upon completion.
   1) Engineer to perform a visual inspection of French drain, exfiltration, or filter system pipes upon placement and prior to covering.

H. Stormwater Retention/Detention Pond and Swale Systems: Systems shall be subject to a visual inspection by the Engineer upon completion of following:
   1) Grading
   2) Vegetative stabilization

**3.9 AS-BUILT SURVEY**

A. General: Provide Engineer 8 signed and sealed copies of as-built survey or surveys as required herein. Provide digital copy in PDF® format and CAD file in AutoCAD® or Terramodel® format.

1) Preparer to be a Registered Land Surveyor or legal entity authorized to practice under FS 472 with such required financial responsibility to pay claims and costs ancillary to providing service.
2) Comply with Florida Minimum Technical Standards for surveying, FAC 5J-17.
3) For projects involving improvements to be dedicated to a municipality or third party, verify and comply with as-built requirements of receiving party. Requirements included herein to be supplied as a minimum.
4) Portions of the work may be certified to regulatory agencies at different times during the life of the project to comply with permit requirements. Coordinate delivery dates of as-built survey with certification needs. Survey may be provided in separate drawings for different systems to meet permit certification times.
5) Denote drawing as as-built or record drawing.
6) All surveys to be furnished prior to request for final approval and payment. Survey is for benefit of Owner, Engineer, and applicable parties accepting such utilities for maintenance and all said parties to be named on drawing.

B. Survey to include water system, sanitary sewer system, storm sewer system, and stormwater management system in accordance with following requirements. If requested, Engineer will provide a digital base map of project.
1) Drawing to show project baseline, boundaries, or other approved references.
2) Use construction document scale.
3) Orient survey to construction drawing coordinate system.
4) Obtain sufficient field information to verify true alignment/limits of systems and allow future marking of systems.
5) Surveyor may utilize information obtained from Contractor as to size and type of system and components thereof. A disclaimer may be placed on survey stating which information was obtained from Contractor.
6) Provide sufficient detail that all parts of system may be readily identified for comparison to Construction Documents. Show the construction document and as-built condition for elements. Construction document requirement to be shown in parenthesis.
7) Obtain measurements at various times as required during construction when improvements will be inaccessible upon completion.
8) Use construction document elevation datum. Show elevation datum reference. Show site benchmark reference.
9) Reference horizontal locations to project boundaries, baseline, or other approved reference point. Locations to be by bearing and distance, station and offset, or coordinates. Coordinates to use same base reference as construction documents.

C. Water System
1) Show horizontal alignment of water system based on field measurements. Drawing to include following:
(a) Size and type of pipe.
(b) Size and type of all fittings, valves and appurtenances including service lines to and including water meter box and any backflow preventers. Show two offset distances to permanent above ground improvements in addition to boundary ties.
(c) Location of sampling points for bacteriological tests.
2) Provide survey within 30 days of completion of construction of the water system.

D. Sanitary Sewer System
1) Show horizontal and vertical alignment of gravity sanitary system based on field measurements. Drawing to include following:
(a) Structures with same designation used on Construction Documents.
(b) Rim elevation and center invert elevation. Provide separate invert for lines not at structure invert.
(c) Length, size, type, and slope of all gravity sewers.
(d) Location of service lines.
2) Show horizontal and vertical alignment of pumping stations based on field measurements. Drawing to include following:
(a) Pumping stations identified with designation used on Construction Documents

(b) Wet well location, top elevation, diameter, invert elevation and influent invert elevation of gravity sewer line.
(c) Valve Box location and dimensions.
(d) Control Panel location.
(e) Fencing type and location.
(f) Limits of gravel, pavement and location of all other above grade improvements.
(g) Pump station parcel boundary when applicable.

3) Show horizontal alignment of sanitary force main system based on field measurements. Drawing to include following:
(a) Size and type of pipe.
(b) Size and type of all fittings, valves and appurtenances.
(c) Existing structure or point of termination, including vertical information.

4) Provide survey within 30 days of completion of construction of the sanitary sewer system.

E. Stormwater Management System

1) Show horizontal and vertical alignment of stormwater management system based on field measurements. Drawing to include following:
(a) Drainage Structures – Locations, dimensions, and elevations of all with structure type and construction document designation.
(b) Pipe - Length, size, type, and slope of all pipes.
(c) Discharge structures - Locations, dimensions, and elevations of all, including weirs, orifices, gates, pumps, pipes, and oil and grease skimmers with structure type and construction document designation.
(d) Side bank and underdrain filters, or exfiltration trenches - Locations, dimensions, and elevations of all, including clean-outs, pipes, connections to control structures and points of discharge to receiving waters. Show top of pipe elevation and clear distance between pipes within filter beds/trenches at a spacing of 25 feet on-center. Show horizontal limits of filter beds/trenches.
(e) Storage areas for treatment and attenuation - Dimensions, elevations, contours or cross-sections of all, sufficient to determine stage-storage relationships of the storage area and the permanent pool depth and volume below the control elevation for normally wet systems. Provide contour area at top of bank, toe of slope, intermediate break points and any specific elevations shown on construction documents. Extend elevations beyond top of bank as required to obtain overtopping discharge elevation.
(f) System grading - Dimensions, elevations, contours, final grades or cross-sections to determine contributing drainage areas, flow directions, and conveyance of runoff to the system discharge points from the site.
(g) Conveyance - Dimensions, elevations, contours, final grades or cross sections of systems utilized to divert off-site runoff around or through the site.
(h) Water levels - Existing water elevations and measurement date.

1) Provide survey within 30 days of completion of construction of the stormwater management system.

# 4. MEASUREMENT AND PAYMENT

## 4.1 GENERAL

A. The contract unit price for pay items shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals necessary for completion in every detail in accordance with plans and specifications. Payment for each pay item shall be by lump sum or unit price as identified in the contract. Unit price pay items will be paid based on quantities computed as determined by the Engineer. For items with a fixed extent, quantities may be based on the limits of the work as computed based on the engineering plans as determined by the engineer and used in the contract. For items where payment is based on actual measure, the method of measure will be as identified in the specific specification section and as follows. When the work to be measured will be rendered inaccessible by other operations, it is the responsibility of the Contractor to confirm the method of measure and to coordinate with the engineer that work has been satisfactorily measured prior to rendering inaccessible.

Failure on the part of the Contractor to coordinate measurement prior to rendering inaccessible may result in payment based on engineer estimates as contained in the contract, or based on investigative work as determined by the engineer and necessary to measure of the extent of the constructed pay item with the cost of such investigative work born by the Contractor.

**4.2 AREAL PAYMENT**

A. When payment is on an areal basis, pay quantities shall be areal extent of Work as calculated using limits of work or plane surveying measurements.
   1) Payment shall not include unauthorized areas beyond limits of work.
   2) Quantities shown on proposal form are Engineer's estimate of Work in-place.
   3) Differences in actual measure of material and estimated measure of material shall not constitute a change in scope of Work and therefore, shall not be a basis for change of unit price.
   4) Payment will be based upon limits of work or actual measure times contract unit price.

**4.3 VOLUMETRIC PAYMENT**

A. When payment is on a volumetric basis, pay quantities shall be computed between original and final position of work, or as defined otherwise herein. Calculation shall be by method of plane surface finite differences, or other method determined by Engineer.
   1) Payment shall not include unauthorized areas beyond limits of work.
   2) Quantities shown on proposal form are Engineer's estimate of Work in-place.
   3) Differences in actual measure of material and estimated measure of material shall not constitute a change in scope of Work and therefore, shall not be a basis for change of unit price.
   4) Payment will be based upon limits of work or actual measure times contract unit price.

**4.4 LINEAR MEASURE PAYMENT**

A. When payment is on a linear basis, pay quantities shall be length of Work as calculated using limits of work or measured using plane surveying measurements.
   1) Payment shall not include unauthorized areas beyond limits of work.
   2) Quantities shown on proposal form are Engineer's estimate of Work in-place.
   3) Differences in actual measure of material and estimated measure of material shall not constitute a change in scope of Work and therefore, shall not be a basis for change of unit price.
   4) Payment will be based upon limits of work or actual measure times contract unit price.

**4.5 LUMP SUM PAYMENT**

A. When payment is on a lump sum basis, Engineer estimated in-place quantities of Work may be provided on proposal form for benefit of Contractor. When provided, such quantity is for verifying Contractor's estimate of work and should be considered only as a rough estimate of primary item or items of work. The quantity is not intended as a representation of total work, may exclude certain portions of work, and is not a bid quantity. Contractor shall assume any and all risk associated with utilization of estimate quantity. Variations between actual quantities required to construct item and provided quantity shall not be taken as a basis of claim by Contractor. Contractor shall be responsible for making all measurements and computations necessary to determine quantity of work.

**END OF SECTION 30 00 00**

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# SECTION 31 10 00
# SITE PREPARATION

## 1. GENERAL

### 1.1 DESCRIPTION OF WORK
A. Includes But Not Limited To:
1) Demolish required existing above and below grade improvements.
2) Prepare site for earthwork and grading including:
(a) Protection of existing trees.
(b) Removal of trees and other vegetation.
(c) Topsoil stripping.
(d) Clearing and/or grubbing.
3) Disposal of all products and debris not required.

### 1.2 RELATED SECTIONS
A. Section 30 00 00 .General Site Work Requirements
B. Section 31 20 00 .Earthwork
C. Section 31 25 00 .Erosion Control and Environmental Protection

**1.3 SUBMITTALS -** comply with requirements of Section 30 00 00.

**1.4 QUALITY ASSURANCE -** comply with requirements of Section 30 00 00.

### 1.5 JOB CONDITIONS
A. Improvements on Adjoining Property (when applicable)
1) Authority for performing removal and alteration work on property adjoining Owner's property will be obtained by Owner prior to award of contract. Contractor to obtain copy of authorization prior to beginning work.
2) Extent of work on adjacent property is indicated on Drawings.

## 2. PRODUCTS

### 2.1 MATERIALS
A. Wood Framing: Posts 4"x4", rails 2"x4", exposed height above grade 4'-0".
B. Construction Fencing: 48" high orange polyethylene fence, such as "E-Z Fence" as manufactured by Sivard Corp., or "Safety Fence" as manufactured by Weathashade or approved equal.
C. Sediment Control Barriers: Refer to Section 31 25 00 - Erosion Control and Environmental Protection

## 3. EXECUTION

### 3.1 PROTECTION OF EXISTING IMPROVEMENTS:
A. Protect all existing improvements, public or private, on or adjacent to site, except items indicated for removal.
B. Protect from disturbance or damage all land monuments and property markers.

### 3.2 PROTECTION OF EXISTING TREES AND VEGETATION
A. Protect against damage existing trees and other vegetation indicated to remain in place.
B. Do not smother trees by stockpiling construction materials or excavated materials within drip line.
C. Do not park within drip line.
D. Provide temporary guards to protect trees and vegetation to remain.
1) Prior to commencing work, construct temporary 4-0" high, double rail, wood fence enclosure a minimum 8'-0" square centered on trees and vegetation to remain. Increase enclosure size as directed on plans for large trees or groups of trees.

2) Maintain fencing during full construction period.
3) Remove fencing when directed by Engineer

E. Interfering branches and roots of trees scheduled to remain may be removed with approval of Engineer.

F. Protect cut and exposed roots:
1) Coat cut faces of roots over 1" in diameter with emulsified asphalt or other coating formulated for use on damaged plant tissues.
2) Temporarily cover exposed roots with wet burlap to prevent roots from drying out; cover with earth as soon as possible.

G. Unauthorized Damage:
1) Work adjacent to or within the drip line of trees does not authorize damage to tree unless tree is shown for removal. Contractor shall protect trees as contained herein. Protection may include alternative construction methods such as boring for utilities or relocation of improvements. Prior to performing work adjacent to or within drip line of any regulated tree, Contractor shall determine location of improvements with respect to tree root system or drip line, assess impacts of work upon trees using appropriate means including the employ of arborists or foresters as necessary. Additionally, Contractor shall determine requirements of regulatory entities for regulated trees prior to performing work. Notify Engineer if work will adversely impact trees.
2) Repair or replace damaged trees and vegetation indicated to remain in a manner acceptable to Engineer. Employ licensed Arborist to repair damage.

H. Water trees and other vegetation to remain within limits of contract work as required to maintain health.

### 3.3 SITE CLEARING

A. General: Remove trees, shrubs, grass and other vegetation, improvements, or obstructions interfering with installation of new construction in accordance with Section 110, FDOT Standard Specifications.

B. Clearing and/or Grubbing: Clear designated areas of trees, shrubs and other vegetation, except as indicated to be protected.
1) Completely remove buildings, timber, brush, stumps, roots, rubbish, debris, and all other obstructions resting on or protruding through ground surface. Unless noted otherwise, extent of work to be to limits of ROW or, in all other cases, to a distance necessary for construction of improvements, but not less than 2 feet beyond pavement, curb, sidewalk, and site structures and 5 feet beyond building perimeters.
2) Fell trees in a manner to prevent injury to trees scheduled to remain.
3) Remove roots, deleterious matter and other debris to a depth of at least one-foot below existing grade or finished subgrade.
4) Scrape surface to a depth of at least six inches and remove all exposed roots, deleterious matter, and debris to a depth of at least one-foot.
5) Completely remove stumps within the limits of work.
6) Use hand methods for grubbing inside the drip line of trees to remain.
7) Strip grass materials to a maximum depth of 1" under tree canopies and carefully till or scarify existing grade to a depth of 1".
8) Fill depressions caused by clearing and grubbing operations with satisfactory soil material in accordance with Section 31 20 00 .Earthwork, unless further excavation or earthwork is indicated.

C. For the purposes of unsuitable material and earthwork quantities, clearing and grubbing will be assumed to remove all soils to a depth of 6 inches below existing grade. These soils will not be included in any computations of unsuitable material quantities.

D. Removal of Improvements: Remove existing above-grade and below-grade improvements necessary to permit indicated work.
1) Remove all abandoned underground piping or conduit, whether known or discovered, located within limits of work unless directed otherwise by Engineer.

**3.4 DISPOSAL OF WASTE MATERIALS** - comply with requirements of Section 30 00 00

## 4. MEASUREMENT AND PAYMENT

### 4.1 GENERAL

A. The contract unit price shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals necessary for completion in every detail in accordance with plans and specifications.
   1) There will be no separate payment for locating existing utilities and structures, clean-up and restoration of property, or other items under this section unless specifically identified on the proposal, bid form or contract.

**END OF SECTION 31 10 00**

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# SECTION 31 20 00
# EARTHWORK

## 1. GENERAL

### 1.1 COORDINATION

A. Construction Documents may contain information relating to earthwork operations beneath proposed buildings. Building plans and specifications, prepared by others, may also contain information relating to earthwork operations beneath proposed buildings. Contractor shall exercise extreme care in coordinating information contained within site work plans and specifications with building plans and specifications. Bring discrepancies to attention of Engineer for resolution. Most stringent conditions shall apply unless directed otherwise.

### 1.2 DESCRIPTION OF WORK

A. Extent of earthwork is indicated on drawings and includes but is not limited to:
   1) Preparation of subgrade for pavements.
   2) Earthwork for roadway and pavements.
   3) Earthwork for site work and structures.
   4) Removal and replacement of unsuitable material.
   5) Earthwork for stormwater system including ditches, channels, swales, detention areas, retention areas, etc.
   6) Earthwork for Utilities: Refer to Section 31 23 16.13, not Work of this section.
   7) Earthwork for buildings and building foundations.

### 1.3 DEFINITIONS

A. Excavation: Excavation consists of removal of material of whatever nature to subgrade elevations, elevations necessary for deep compaction, construction, or as required, and subsequent disposal or stockpiling.

B. Fill, Backfill, or Embankment: Placement of suitable material to lines and grades shown, or required for construction of improvements, except for backfill of areas of excavated unsuitable material. For purposes of payment, backfill of areas of excavated unsuitable material to be classified under pay item unsuitable material. Embankment is generally described as fill placed above existing grade but may be used generically to describe all fill except as noted above.

C. Unauthorized excavation: Removal of materials beyond indicated lines, grades and cross-sections without specific direction of Engineer.

D. Subbase: A constructed bed of material laid under a road base or pavement base on natural ground surface. Material may consist of fill to bring ground surface to proposed elevations or may consist of a design layer of specific material to provide structural strength to pavement section.

E. Subgrade: The natural ground beneath a road base, pavement base or other structure.
   1) The terms subbase and subgrade may be used generically in certain instances to indicate material beneath a road or pavement base without regard to whether material is naturally occurring or not. It is intent of specifications to make a distinction where a distinction is warranted. However, unless warranted, such a distinction may not be shown.

F. Structures: Site structures including but not limited to endwalls, inlets, junction boxes, site retaining walls, rip-rap, etc., except for buildings and building components.

G. Suitable Soils: Soils suitable for providing required engineering properties beneath or adjacent to proposed work.

H. Unsuitable soils: Soils which are identified as unsuitable for location within limits of work.

I. Unsuitable material: Unsuitable material includes unsuitable soils, waste material, man-made material, trash, debris, or other material as identified by Geotechnical Engineer as unsuitable within limits of work.

J. Standard Minimum Slope: The minimum safe allowable slope (smallest ratio of run divided by rise) of bare suitable material required to support the slope without shear failure (approximately 2 to 1).

### 1.4 RELATED WORK

A. Section 30 00 00 - General Site Work Requirements

B. Section 31 32 00 - Stabilization
C. Section 32 12 16 - Asphaltic Concrete Pavement

**1.5 SUBMITTALS -** comply with requirements of Section 30 00 00.

1.6 **QUALITY ASSURANCE -** comply with requirements of Section 30 00 00.

# 2. PRODUCTS

## 2.1 SOIL MATERIALS

A. Satisfactory (suitable) soil materials: Materials complying with AASHTO soil classification groups A-1, A-2-4, A-2-5, A-3 and sand to slightly silty sand material with a maximum percentage of fines as specified in the Geotechnical Report, but not more than 15% by dry weight finer than number 200 US mesh sieve. Material to be free of clay, rock or gravel larger than two inches in any dimension, debris, refuse, rubble, organics and other deleterious matter.
   1) Do not use material from on-site sources for placement beneath pavements and structures unless authorized in Geotechnical Report or by Geotechnical Engineer in writing.
B. Unsatisfactory (unsuitable) soil materials: Materials complying with AASHTO soil classification groups A-2-6, A-2-7, A-4, A-5, A-6, A-7 and A-8 or as identified by Geotechnical Engineer.
   1) Unsatisfactory materials include but are not limited to materials containing roots, organics, peat, muck, clay, trash, debris, frozen materials and stones larger than three inches. Unsatisfactory materials may also include manmade fills, refuse or backfills from previous construction.
C. Subbase Material: Unless otherwise noted, naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, natural or crushed sand with less than 15% passing No. 200 sieve and a limerock bearing ratio value of at least 50.
D. Drainage Fill: Unless otherwise noted, washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100% passing a 1 1/2" sieve and not more than 5% passing a No. 4 sieve.
E. Backfill and Fill Materials: Satisfactory soil materials.

# 3. EXECUTION

## 3.1 EXCAVATION

A. General: Excavate to lines, grades and cross-sections indicated and/or necessary to permit indicated work.
B. Unauthorized excavation, as well as remedial Work directed by Engineer, shall be at Contractor's expense.
C. Unsuitable Materials: When unsuitable material is discovered beneath and/or adjacent to limits of work, notify Geotechnical Engineer prior to performing any work in affected area. Geotechnical Engineer shall make a determination on suitability or unsuitability of material remaining beneath proposed improvements. When directed by Geotechnical Engineer, excavate unsuitable materials to lines, grades, and cross sections indicated on plans or as directed. When payment is based on volumetric measure, insure that necessary elevations have been obtained by party responsible for volumetric computation prior to beginning work. In no case shall unsuitable material remain unless directed by Geotechnical Engineer. Any improvements placed upon unsuitable material without written approval may require removal and replacement at no cost to Owner.
   1) Geotechnical Engineer to inspect bottom of excavation and approve removal prior to backfilling.
   2) Beneath pavement areas, depths and widths of removal to be in accordance with details contained in plans or as directed by Geotechnical Engineer.
   3) Beneath building areas, removal, when required, shall be to full depth and for a distance equal to depth of cut beyond work, but not less than 10 feet or as directed by Geotechnical Engineer.
   4) Temporary dewatering may be required during inspection of excavation bottom. Dewater as required.
D. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.
   1) Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.
E. Dispose of excess soil material and waste materials as herein specified.

## 3.2 STABILITY OF EXCAVATIONS

A. General: Perform operations in accordance with Federal, State, and Local regulations including Trench Safety Act, Florida Statute 553.6.

B. Provide special provisions when required. Failure to provide necessary items and meet requirements of laws shall not relieve Contractor of sole liability for trench safety.
   1) Provide engineering design and certification, when required.
   2) Provide all necessary certifications, cost data, and documentation required by law.
   3) For trench excavations in excess of 5 feet deep, the contract bid submitted by the contractor who will perform such excavation shall include the following.
      (a) A reference to the trench safety standards that will be in effect during the period of construction of the project.
      (b) Written assurance by the contractor performing the trench excavation that such contractor will comply with the applicable trench safety standards.
      (c) A separate item identifying the cost of compliance with the applicable trench safety standards. Submittal of the information shall be on the form contained herein and shall be attached to all bids.
   4) A contractor performing trench excavation shall comply with the following
      (a) As a minimum, comply with the excavation safety standards which are applicable to a project.
      (b) Adhere to any special shoring requirements, if any, of the state or political subdivisions which may be applicable to such a project.
      (c) Consider available geotechnical information in the contractor's design of the trench safety system which it will employ on the project.

C. Slope sides of excavations to comply with codes and ordinances having jurisdiction.
   1) Maintain sides and slopes of excavations in safe condition until completion of backfilling.

D. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
   1) Provide materials for shoring and bracing in good serviceable condition.
   2) Establish requirements to comply with codes and authorities having jurisdiction.
   3) Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.

## 3.3 DEWATERING OF EXCAVATIONS

A. General: Prevent surface water from flowing into excavations and from flooding project site and surrounding area. Excavation shall be free from water before placing fill, compaction, or installation of structures.
   1) Establish and maintain temporary drainage ditches and/or diversion structures outside excavation limits to prevent surface water from excavations. Do not use trench excavations as temporary drainage ditches.
   2) Provide all necessary pumps, underdrains, wellpoint systems and other means for removing water from excavations and other parts of work. Continue dewatering operations until backfill has progressed above ground water table.
   3) Dispose of water in such a manner as will not cause injury to public health, to public or private property, to work completed or in progress, to surface of the streets, or cause any interference with use of the same by the public.
   4) Use appropriate erosion and sediment control procedures to prevent siltation or sediment disposal off-site.
   5) Obtain all required dewatering permits.

## 3.4 BACKFILL, FILL, AND EMBANKMENT

A. General: Backfill, Fill and Embankment Work includes fill to the lines, grades and cross-sections indicated or as required to construct improvements.
   1) Place suitable soil material in layers to required elevation and compaction, for each area classification as contained herein or as shown on the construction drawings.

B. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions and deleterious materials from ground surface prior to placement of fills. Flow, strip or break-up sloped surfaces steeper than one vertical to four horizontal so that fill material will bond with existing surface.

C. When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture

content, and compact to required depth and percentage of maximum density.

D. Placement and Compaction: Place backfill and fill materials in layers not more than 12" in loose depth for material compacted by heavy compaction equipment, and not more than six inches in loose depth for material compacted by hand-operated tampers. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification contained herein or as shown on the construction drawings
   1) Prior to compaction, moisten or aerate each layer as necessary to provide optimum moisture content.
   2) Place evenly adjacent to structures, piping or conduit to required elevations. Take care to prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping or conduit to approximately same elevation in each lift.
   3) Placement in Unstable Areas: In areas not capable of supporting the weight of hauling equipment, place fill by dumping successive loads in a uniformly distributed layer of a thickness not greater than that necessary to support hauling equipment. Place remainder in accordance with requirements contained herein.
   4) Placement on Steep Slopes: For slopes more than 20 degrees from the horizontal, plow existing grade to cut in steps before filling.
   5) Placement in Pavement Areas: Prior to backfilling, compact bottom of excavation beneath pavement and extending 5 feet beyond perimeter to specified density and depth. Place fill in accordance with requirements contained herein.
   6) Placing in Building Areas: Prior to backfilling, compact bottom of excavation in area beneath building and extending 5 feet beyond perimeter to specified density and depth. Place fill in accordance with requirements contained herein.

E. Unsuitable Material: Upon notification to proceed by Geotechnical Engineer, replace excavated areas of unsuitable material with suitable material in accordance with requirements contained herein and following.
   1) Do not place backfill in standing water.
   2) Maintain dry condition during backfill until level exceeds elevation of ground water table.

F. Backfill excavations as promptly as Work permits, but not until completion of following:
   1) Inspection, testing, approval and recording of locations of underground utilities.
   2) Removal of concrete formwork. No formwork will be allowed to remain in place.
   3) Removal of shoring and bracing, and backfilling of voids with satisfactory materials.
   4) Removal of trash and debris.

## 3.5 GRADING

A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finish surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.

B. Grading Adjacent to Building: Grade areas adjacent to building lines to drain away from structures and to prevent ponding.

C. Finish surfaces, subgrade or finish grade, free from irregular changes and as follows:
   1) Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10' above or below required subgrade elevations.
   2) Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 0.05' above or below required subgrade elevation.
   3) Ditches, Channels and Swales: Shape to line, grade and cross-section, with finish surface not more than 0.05' above or below required elevations and such that no water will be impounded unless so indicated on plans.
   4) Detention and Retention Areas: Shape to line, grade and cross-section with finish surface not more than 0.05' above or below required elevations.
   5) Pavements: Shape surface of areas under pavement to line, grade and cross-section, with finish surface not more than 3/8" above or below required subgrade elevation.
   6) Building Areas: Shape surface of areas under building to line, grade and cross-section, with finish surface not more than 1/8" above or below required subgrade elevation.

### 3.6 COMPACTION

A. General: Control soil compaction during construction providing minimum percentage of density specified for each layer of material for the area classification indicated below or as shown on the construction drawings.

B. Percentage of Maximum Density Requirements: Compact soil to not less than following percentages of Modified Proctor maximum dry density determined in accordance with AASHTO T-180/ASTM D-1557.

1) Drainage Structures: Unless noted otherwise on plans, compact top 12 inches of subgrade and each layer of backfill or fill material to 95% maximum dry density.
2) Pavement: Unless noted otherwise on plans, compact each layer of backfill or fill material to 95% maximum dry density. Compact subgrade to 95% maximum dry density to a depth of 12 inches below grade. Compaction shall be by a vibratory roller. When required, stabilize the top 12 inches of subgrade or subbase in accordance with other Division-30 sections for stabilization.
3) Stormwater System: Unless noted otherwise on plans, compact top eight inches of subgrade and each layer of backfill or fill material to 95% maximum dry density.
4) Lawn or Unpaved Areas: Unless noted otherwise on plans, compact top 8 inches of subgrade and each layer of backfill or fill material to the density of existing soils but not less than 90% of the maximum dry density.
5) Walkways, Slabs, Ditch Pavement and Miscellaneous Structures: Unless noted otherwise on plans, compact each layer of backfill or fill material at 95% maximum dry density. The top 12 inches of subgrade shall be compacted to a minimum of 95% maximum dry density.
6) Buildings and Foundations: Unless noted otherwise, compact each layer of backfill or fill material at 95% maximum dry density. Compact subgrade to 95% maximum dry density to a depth of 12 inches below grade. Compaction shall be by a vibratory roller.

C. Moisture Control: Where subgrade or soil layer must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or soil layer, to prevent free water appearing on surface during or subsequent to compaction operations. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

D. Yielding Areas: Any areas which show signs of yielding during compaction operations shall be brought to attention of Owners Geotechnical Engineer.

### 3.7 TESTING AND INSPECTION REQUIREMENTS - comply with requirements of Section 30 00 00.

### 3.8 MAINTENANCE

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris. Erosion control shall be by stabilizing vegetation, either permanent or temporary, placed within five days of grading.

B. Repair and re-establish grades in settled, eroded and rutted areas to specified tolerances.

C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape and compact to required density prior to further construction.

D. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact and replace surface treatment. Restore appearance, quality and condition of surface or finish to match adjacent Work and eliminate evidence of restoration to greatest extent possible.

### 3.9 DISPOSAL OF EXCESS AND WASTE MATERIALS - Comply with requirements of Section 30 00 00.

## 4. MEASUREMENT AND PAYMENT

### 4.1 GENERAL

A. The contract unit price shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals necessary for completion in every detail in accordance with plans and

specifications.

1) There will be no separate payment for clean up and restoration of property, or other items under this section unless specifically identified on the proposal, bid form or contract.

B. Unsuitable Materials: When payment is on a volumetric basis, contract unit price shall be compensation in full for removal of one cubic yard (in-place measure) of unsuitable material and replacement with one cubic yard (in-place measure) of suitable material, and shall include disposal of unsuitable material as specified herein.

1) Removal of unsuitable material within areas above subgrade shall not be paid for as unsuitable material but shall be considered as normal excavation.
2) Pay quantities shall be based on volume between lowest subgrade elevation (either pre-developed less clearing and grubbing, design or actual) and actual or design bottom of excavation (whichever results in least volume). When subgrade area is pre-developed area less clearing and grubbing, field survey data obtained prior to clearing and grubbing may be used at discretion of Engineer. When used, clearing and grubbing will be assumed to remove all soils to a depth of 6 inches below existing grade. These soils will not be included in computation of quantities.
3) Measurement shall be by Engineer or Owner's Representative in accordance with the methods contained in Section 30 00 00. Contractor shall be responsible for coordinating measurement.
4) Payment shall only include Work to limits, lines and grades shown on plans or directed by Engineer.

**END OF SECTION 31 20 00**

# SECTION 31 23 16
# EARTHWORK FOR UTILITIES

## 1. GENERAL

### 1.1 DESCRIPTION OF WORK
A. Extent of work is indicated on drawings and includes but is not limited to:
   1) Excavation for utility systems to points of connection or termination.
   2) Trenching for utility systems to points of connection or termination.
   3) Preparation of utility system subgrade and bedding.
   4) Placement of select granular bedding material.
   5) Backfilling for utility systems to points of connection or termination.
   6) Finish grading and stabilization
   7) Removal and replacement of pavement.

### 1.2 RELATED WORK
A. Section 30 00 00 - General Site Work Requirements
B. Section 31 20 00 - Earthwork
C. Section 31 25 00 - Erosion Control and Environmental Protection
D. Section 32 92 19 - Grassing by Seeding

### 1.3 DEFINITIONS
A. Pipe Bedding: Pipe bedding is defined as contact between a pipe and soil foundation on which it rests.
B. Unauthorized excavation: Removal of materials beyond indicated lines, grades and cross-sections without specific direction of Engineer.
C. Suitable Soils: Soils suitable for providing required engineering properties beneath or adjacent to proposed work.
D. Unsuitable soils: Soils identified as unsuitable for location within limits of work.
E. Unsuitable material: Unsuitable material includes unsuitable soils, waste material, man-made material, trash, debris, or other material as identified by Geotechnical Engineer as unsuitable within limits of work.

**1.4 SUBMITTALS -** comply with requirements of Section 30 00 00.

**1.5 QUALITY ASSURANCE -** comply with requirements of Section 30 00 00.

## 2. PRODUCTS

### 2.1 SOIL MATERIALS
A. Satisfactory (suitable) soil materials: Materials complying with AASHTO soil classification groups A-1, A-2-4, A-2-5, A-3 and sand to slightly silty sand material with no more than 15% by dry weight finer than number 200 US mesh sieve. Material to be free of clay, rock or gravel larger than two inches in any dimension, debris, refuse, rubble, organics and other deleterious matter.
   1) Do not use material from on-site sources unless authorized in Geotechnical Report or by Geotechnical Engineer in writing.
B. Unsatisfactory (unsuitable) soil materials: Materials complying with AASHTO soil classification groups A-2-6, A-2-7, A-4, A-5, A-6, A-7 and A-8 or as identified by Geotechnical Engineer.
   1) Unsatisfactory materials include but are not limited to materials containing roots, organics, peat, muck, clay, trash, debris, frozen materials and stones larger than three inches. Unsatisfactory materials also include manmade fills, refuse or backfills from previous construction.
C. Backfill and Fill Materials: Satisfactory soil materials.
D. Unyielding material: Rock and gravely soils with stones greater than three inches.
E. Unstable material: Material too wet to properly support the utility pipe, conduit or appurtenance structure.

F. Select Granular Material: Well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles with not more than 15% by weight of material passing a No. 200 mesh sieve and not less than 95% by weight passing the one inch sieve. The maximum allowable aggregate size shall be two inches or maximum size recommended by pipe manufacturer, whichever is smaller.

# 3. EXECUTION

## 3.1 EXCAVATION

A. General: Excavate to lines, grades and cross-sections indicated and/or necessary to permit indicated work.
   1) Includes excavation of pavements and other obstructions visible on ground surface; underground structures utilities and other items indicated to be demolished and removed; together with earth and other materials encountered.
   2) Conduct work in accordance with Section 31 20 00 - Earthwork.
   3) Conduct work in accordance with Section 31 25 00 - Erosion Control and Environmental Protection.

B. Unauthorized excavation, as well as remedial Work directed by Engineer, shall be at Contractors expense.

C. Trench Excavation: Trench width below top of pipe shall not exceed 24 inches plus pipe outside diameter (OD) for pipes of less than 24 inches inside diameter, and shall not exceed 36 inches plus OD for larger sizes.
   1) Where recommended trench widths are exceeded, redesign using stronger pipe or special installation procedures. Cost of redesign and increased cost of pipe or installation procedures shall be borne by Contractor.
   2) When unsuitable material is encountered, notify Engineer for direction prior to performing work.
   3) Side slopes shall vary dependent upon depth, type of soils, and position of surface structures.

D. Trench Grade: Grade uniformly to lines and grades shown on plans less any additional excavation for special bedding.

E. Removal of Unyielding Material: Where unyielding material is encountered in trench bottom, remove material four inches below required grade and replace with suitable material.

F. Removal of Unstable Material: Where unstable material is encountered in trench bottom, remove to 1/4 outside pipe diameter but not less than four inches and replace to proper grade with select granular material.
   1) When required due to fault or neglect of Contractor in his performance of work, resulting material shall be excavated and replaced without additional cost to Owner. When removal of unstable material is required due to presence of unsuitable material, payment shall be as contained herein.

G. Appurtenance Excavation: Excavation for manholes, catch-basins, inlets or similar structures to be at least 12 inches clear between outer structure surfaces and face of excavation or support members or of sufficient size to permit placement and removal of forms for full length and width of structure footings and foundations as shown.
   1) Removal of unstable material shall be as specified above.
   2) Use special care to protect bottom of excavation when concrete or masonry is to be placed in an excavated area. Do not excavate to final grade level until just before concrete or masonry is placed.

H. Material Storage: During excavation, stockpile material satisfactory for backfilling in an orderly manner at a distance from banks of trench sufficient to avoid overloading and to prevent slides or cave-ins.

**3.2 STABILITY OF EXCAVATIONS -** Comply with requirements of Section 31 20 00.

**3.3 DEWATERING OF EXCAVATIONS -** Comply with requirements of Section 31 20 00.

## 3.4 BOTTOM PREPARATION

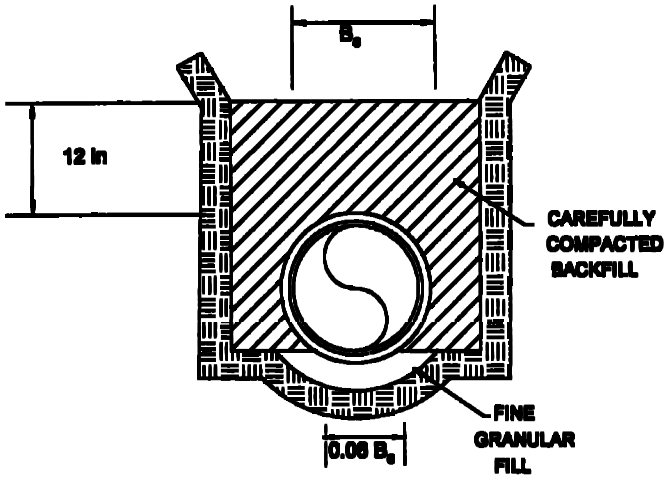
A. Bottom Preparation: Accurately shape to provide uniform, stable bedding of pipe.

1) Adjust line and grade by scraping away or adding adequately compacted material under pipe. Wedges, blocks, or beating on pipe is prohibited.

**3.5 PIPE BEDDING**

A. General: Bed pipe to provide uniform bearing and support for bottom quadrant of each section of pipe.
   1) Remove point bearing stones, stumps, limbs, or other debris larger than 2 inches in any dimension, or as recommended by the pipe manufacturer, whichever is smaller.
   2) Excavate bell holes to necessary size at each joint or coupling to eliminate point bearing.
   3) Provide stable pipe support and bottom reaction of barrel.

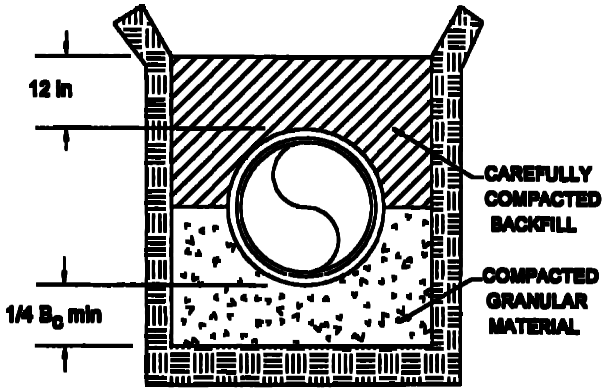
B. Select one of following bedding classes to obtain a stable support for pipe.
   1) Class B (First Class Bedding): Class B bedding may be achieved by either of following methods.
      (a) Shaped Bottom with Tamped Backfill - Shape bottom to conform to a cylindrical surface with a radius of at least 2 inches greater than radius to outside of pipe and with a width sufficient to allow six-tenths of width of pipe barrel to be bedded in fine granular fill placed in shaped excavation. Carefully place and compact backfill at sides of pipe to a thickness of at least 12 inches above top of pipe.




**SHAPED BOTTOM WITH TAMPED BACKFILL**

**CLASS B(1)**

(b) Compacted Granular Bedding with Tamped Backfill - Bed pipe in compacted granular material placed on a flat trench bottom. The granular bedding shall have a minimum thickness of one fourth outside pipe diameter and shall extend halfway up pipe barrel at sides. Carefully backfill and compact material to a minimum depth of 12 inches over top of pipe.

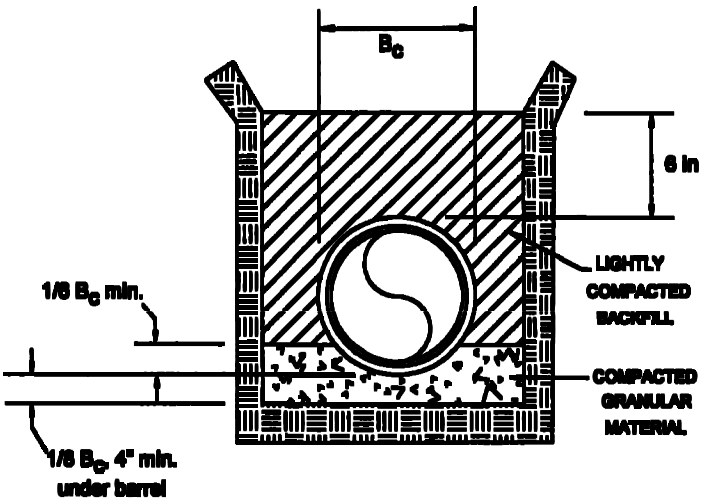



**COMPACTED GRANULAR BEDDING**

# CLASS B(2)

2) Class C (Ordinary Bedding): Class C bedding may be achieved by either of the following methods.
   (a) Shaped Bottom - Bed pipe with ordinary" care in an earth foundation formed in trench bottom by a shaped excavation to fit pipe barrel with reasonable closeness for a width of at least 50 percent of outside pipe diameter. Fill sides and area over pipe to a minimum depth of 6 inches above top of pipe with lightly compacted fill.

   (b) Compacted Granular Bedding with a Tamped Backfill - Bed pipe in compacted granular material placed on a flat trench bottom. The granular bedding shall have a minimum thickness of 4 inches under barrel and extend one-tenth to one-sixth of outside diameter up pipe barrel at sides. Fill remainder of sides and to a minimum depth of 6 inches over top of pipe with lightly compacted backfill.




**GRANULAR BEDDING**

**CLASS C(2)**

**3.6 BACKFILLING**

A. General: Backfilling shall be accomplished in three zones, haunching, initial backfill and final backfill for each area classification.

B. Trench Backfill: Backfill to grade shown.
   1) Backfill to two feet above top of pipe prior to performing pressure tests.
   2) Do not place backfill in standing water.
   3) Maintain dry condition during backfill until level exceeds elevation of ground water table.

C. Compaction: Compact fill layers to minimum percentage of maximum dry density in accordance with AASHTO T-1 80 for each area classification and zone as indicated below.
   1) Obtain proper moisture content in soils prior to compaction by wetting or drying as required.

D. Haunching .Carefully place and compact backfill material in thin level lifts not to exceed 4 inches under pipe haunch and to springline (midpoint) of pipe to provide side support.
   1) Prevent vertical and lateral displacement of pipe from proper alignment.
   2) Compact soils using hand operated tamping devices or other methods to 95 percent of maximum dry density in accordance with AASHTO T-180.
   3) Ensure thorough compaction of fill under haunches of pipe.

E. Initial Backfill: Carefully place and compact backfill material in thin level lifts not to exceed 6 inches in thickness from springline to a height of at least one foot above pipe.
   1) Place fill evenly on both sides of pipe for full length of pipe.
   2) Compact soils using hand operated tamping devices or other methods to 95 percent of maximum dry density in accordance with AASHTO T-180.
   3) Ensure thorough compaction of the fill.

F. Final Backfill: Backfill remainder of the trench, except beneath pavement, structures, or other items as specified herein, with native satisfactory material placed in thin level lifts not to exceed 12 inches in thickness and compacted to 90 percent of maximum dry density in accordance with AASHTO T-180.

1) Place fill from top of initial backfill to lines and grades shown on construction documents or existing grade but not less than 12 inches clear.

G. Final Backfill under Roadways and Structures: Place suitable soils, either native or borrow, in thin level lifts not to exceed 12 inches in thickness and compact to 95 percent of maximum dry density in accordance with AASHTO T180.
   1) Place fill from top of initial backfill to bottom of base or existing grade.
   2) For utilities installed after subgrade preparation, prepare subgrade in accordance with requirements for pavement section at no additional compensation.
   3) Do not use unsuitable soils.

H. Final Backfill under Appurtenances: After manhole, catch-basin, inlet or similar structure has been constructed and concrete has been allowed to cure for three days minimum, place fill in manner that structure will not be damaged by shock of falling earth.
   1) Deposit and compact material as specified for final backfill or final backfill under roadways and structures, and place in manner to prevent eccentric loading and excessive stress on structure.

I. Unsuitable Material: In locations where native material is unsuitable soils, notify Engineer for directions prior to backfill operations. Final backfill shall consist of native unsuitable soils or suitable soils as directed by Engineer. Replacement of native unsuitable soils with suitable soils shall be paid for as specified herein, except, in locations where removal and replacement of unsuitable soils is covered and paid for under other sections no additional compensation will be due.

**3.7 FINISHING**

A. Areas outside limits of other work: Finish grade disturbed areas to provide a smooth, uniform and attractive surface free of exposed roots and debris and then stabilize in accordance with Section 32 92 19 -Grassing by Seeding or repair pavement in accordance with details contained on drawings or to match existing.

**3.8 DISPOSAL OF EXCESS AND WASTE MATERIALS -** Comply with requirements of Section 30 00 00.

**3.9 TESTING AND INSPECTION REQUIREMENTS -** comply with requirements of Section 30 00 00.

## 4. MEASUREMENT AND PAYMENT

**4.1 GENERAL**

A. The contract unit price shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals necessary for completion in every detail in accordance with plans and specifications.
   1) There will be no separate payment for work covered by this section except as contained herein, and all costs in connection therewith shall be included in the contract price for item or structure to which it pertains.
   2) Bedding: No separate payment will be made for this item.
   3) Replacement of unsuitable or unstable material with suitable material in the bedding, haunching and initial backfill areas: No separate payment will be made for this item.
   4) Unsuitable materials in the final backfill zone: The contract unit price shall be compensation in full for one cubic yard, in-place, of suitable fill material. Measurement shall be as computed by the Engineer. When a separate unit price is not available for this item, at discretion of Engineer, a unit price equal to one-half unit price for removal and replacement of unsuitable material will be used.

**END OF SECTION 31 23 16**

# SECTION 31 23 16
# EARTHWORK FOR UTILITIES

## 1. GENERAL

### 1.1 DESCRIPTION OF WORK
A. Extent of work is indicated on drawings and includes but is not limited to:
   1) Excavation for utility systems to points of connection or termination.
   2) Trenching for utility systems to points of connection or termination.
   3) Preparation of utility system subgrade and bedding.
   4) Placement of select granular bedding material.
   5) Backfilling for utility systems to points of connection or termination.
   6) Finish grading and stabilization
   7) Removal and replacement of pavement.

### 1.2 RELATED WORK
A. Section 30 00 00 - General Site Work Requirements
B. Section 31 20 00 - Earthwork
C. Section 31 25 00 - Erosion Control and Environmental Protection
D. Section 32 92 19 - Grassing by Seeding

### 1.3 DEFINITIONS
A. Pipe Bedding: Pipe bedding is defined as contact between a pipe and soil foundation on which it rests.
B. Unauthorized excavation: Removal of materials beyond indicated lines, grades and cross-sections without specific direction of Engineer.
C. Suitable Soils: Soils suitable for providing required engineering properties beneath or adjacent to proposed work.
D. Unsuitable soils: Soils identified as unsuitable for location within limits of work.
E. Unsuitable material: Unsuitable material includes unsuitable soils, waste material, man-made material, trash, debris, or other material as identified by Geotechnical Engineer as unsuitable within limits of work.

**1.4 SUBMITTALS -** comply with requirements of Section 30 00 00.

**1.5 QUALITY ASSURANCE -** comply with requirements of Section 30 00 00.

## 2. PRODUCTS

### 2.1 SOIL MATERIALS
A. Satisfactory (suitable) soil materials: Materials complying with AASHTO soil classification groups A-1, A-2-4, A-2-5, A-3 and sand to slightly silty sand material with no more than 15% by dry weight finer than number 200 US mesh sieve. Material to be free of clay, rock or gravel larger than two inches in any dimension, debris, refuse, rubble, organics and other deleterious matter.
   1) Do not use material from on-site sources unless authorized in Geotechnical Report or by Geotechnical Engineer in writing.
B. Unsatisfactory (unsuitable) soil materials: Materials complying with AASHTO soil classification groups A-2-6, A-2-7, A-4, A-5, A-6, A-7 and A-8 or as identified by Geotechnical Engineer.
   1) Unsatisfactory materials include but are not limited to materials containing roots, organics, peat, muck, clay, trash, debris, frozen materials and stones larger than three inches. Unsatisfactory materials also include manmade fills, refuse or backfills from previous construction.
C. Backfill and Fill Materials: Satisfactory soil materials.
D. Unyielding material: Rock and gravely soils with stones greater than three inches.
E. Unstable material: Material too wet to properly support the utility pipe, conduit or appurtenance structure.

F. Select Granular Material: Well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles with not more than 15% by weight of material passing a No. 200 mesh sieve and not less than 95% by weight passing the one inch sieve. The maximum allowable aggregate size shall be two inches or maximum size recommended by pipe manufacturer, whichever is smaller.

# 3. EXECUTION

## 3.1 EXCAVATION

A. General: Excavate to lines, grades and cross-sections indicated and/or necessary to permit indicated work.
   1) Includes excavation of pavements and other obstructions visible on ground surface; underground structures utilities and other items indicated to be demolished and removed; together with earth and other materials encountered.
   2) Conduct work in accordance with Section 31 20 00 - Earthwork.
   3) Conduct work in accordance with Section 31 25 00 - Erosion Control and Environmental Protection.

B. Unauthorized excavation, as well as remedial Work directed by Engineer, shall be at Contractors expense.

C. Trench Excavation: Trench width below top of pipe shall not exceed 24 inches plus pipe outside diameter (OD) for pipes of less than 24 inches inside diameter, and shall not exceed 36 inches plus OD for larger sizes.
   1) Where recommended trench widths are exceeded, redesign using stronger pipe or special installation procedures. Cost of redesign and increased cost of pipe or installation procedures shall be borne by Contractor.
   2) When unsuitable material is encountered, notify Engineer for direction prior to performing work.
   3) Side slopes shall vary dependent upon depth, type of soils, and position of surface structures.

D. Trench Grade: Grade uniformly to lines and grades shown on plans less any additional excavation for special bedding.

E. Removal of Unyielding Material: Where unyielding material is encountered in trench bottom, remove material four inches below required grade and replace with suitable material.

F. Removal of Unstable Material: Where unstable material is encountered in trench bottom, remove to 1/4 outside pipe diameter but not less than four inches and replace to proper grade with select granular material.
   1) When required due to fault or neglect of Contractor in his performance of work, resulting material shall be excavated and replaced without additional cost to Owner. When removal of unstable material is required due to presence of unsuitable material, payment shall be as contained herein.

G. Appurtenance Excavation: Excavation for manholes, catch-basins, inlets or similar structures to be at least 12 inches clear between outer structure surfaces and face of excavation or support members or of sufficient size to permit placement and removal of forms for full length and width of structure footings and foundations as shown.
   1) Removal of unstable material shall be as specified above.
   2) Use special care to protect bottom of excavation when concrete or masonry is to be placed in an excavated area. Do not excavate to final grade level until just before concrete or masonry is placed.

H. Material Storage: During excavation, stockpile material satisfactory for backfilling in an orderly manner at a distance from banks of trench sufficient to avoid overloading and to prevent slides or cave-ins.

**3.2 STABILITY OF EXCAVATIONS -** Comply with requirements of Section 31 20 00.

**3.3 DEWATERING OF EXCAVATIONS -** Comply with requirements of Section 31 20 00.

## 3.4 BOTTOM PREPARATION

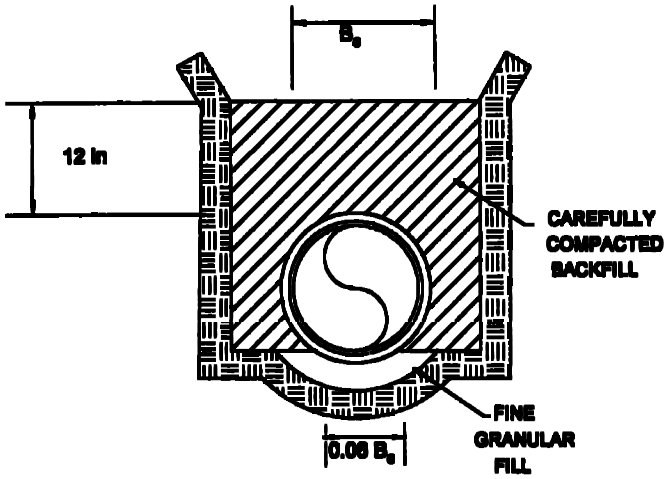
A. Bottom Preparation: Accurately shape to provide uniform, stable bedding of pipe.

1) Adjust line and grade by scraping away or adding adequately compacted material under pipe. Wedges, blocks, or beating on pipe is prohibited.

**3.5 PIPE BEDDING**

A. General: Bed pipe to provide uniform bearing and support for bottom quadrant of each section of pipe.
   1) Remove point bearing stones, stumps, limbs, or other debris larger than 2 inches in any dimension, or as recommended by the pipe manufacturer, whichever is smaller.
   2) Excavate bell holes to necessary size at each joint or coupling to eliminate point bearing.
   3) Provide stable pipe support and bottom reaction of barrel.

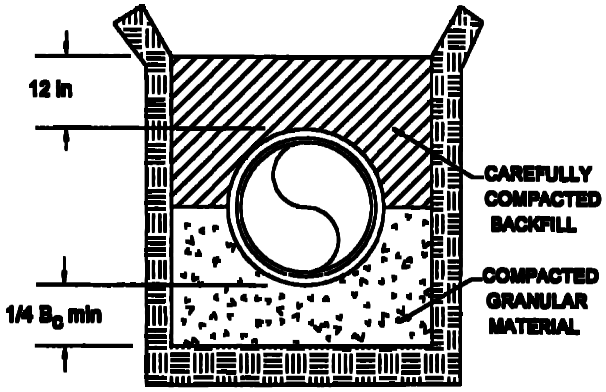
B. Select one of following bedding classes to obtain a stable support for pipe.
   1) Class B (First Class Bedding): Class B bedding may be achieved by either of following methods.
      (a) Shaped Bottom with Tamped Backfill - Shape bottom to conform to a cylindrical surface with a radius of at least 2 inches greater than radius to outside of pipe and with a width sufficient to allow six-tenths of width of pipe barrel to be bedded in fine granular fill placed in shaped excavation. Carefully place and compact backfill at sides of pipe to a thickness of at least 12 inches above top of pipe.




**SHAPED BOTTOM WITH TAMPED BACKFILL**

**CLASS B(1)**

(b) Compacted Granular Bedding with Tamped Backfill - Bed pipe in compacted granular material placed on a flat trench bottom. The granular bedding shall have a minimum thickness of one fourth outside pipe diameter and shall extend halfway up pipe barrel at sides. Carefully backfill and compact material to a minimum depth of 12 inches over top of pipe.

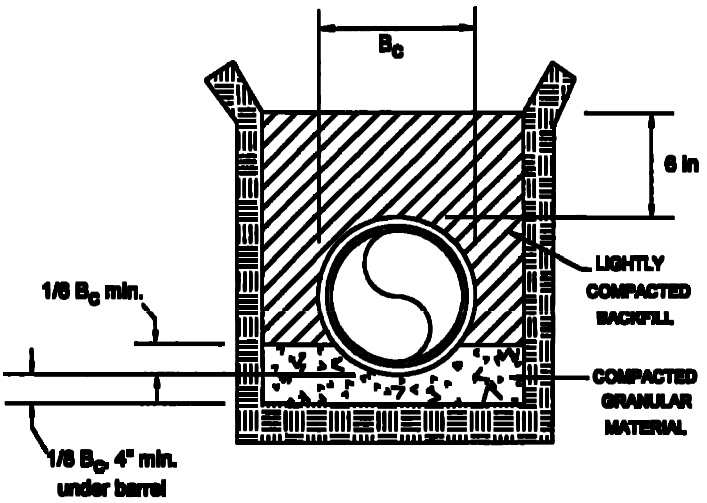



**COMPACTED GRANULAR BEDDING**

# CLASS B(2)

2) Class C (Ordinary Bedding): Class C bedding may be achieved by either of the following methods.
   (a) Shaped Bottom - Bed pipe with ordinary" care in an earth foundation formed in trench bottom by a shaped excavation to fit pipe barrel with reasonable closeness for a width of at least 50 percent of outside pipe diameter. Fill sides and area over pipe to a minimum depth of 6 inches above top of pipe with lightly compacted fill.

   (b) Compacted Granular Bedding with a Tamped Backfill - Bed pipe in compacted granular material placed on a flat trench bottom. The granular bedding shall have a minimum thickness of 4 inches under barrel and extend one-tenth to one-sixth of outside diameter up pipe barrel at sides. Fill remainder of sides and to a minimum depth of 6 inches over top of pipe with lightly compacted backfill.




**GRANULAR BEDDING**

**CLASS C(2)**

**3.6 BACKFILLING**

A. General: Backfilling shall be accomplished in three zones, haunching, initial backfill and final backfill for each area classification.

B. Trench Backfill: Backfill to grade shown.
   1) Backfill to two feet above top of pipe prior to performing pressure tests.
   2) Do not place backfill in standing water.
   3) Maintain dry condition during backfill until level exceeds elevation of ground water table.

C. Compaction: Compact fill layers to minimum percentage of maximum dry density in accordance with AASHTO T-1 80 for each area classification and zone as indicated below.
   1) Obtain proper moisture content in soils prior to compaction by wetting or drying as required.

D. Haunching .Carefully place and compact backfill material in thin level lifts not to exceed 4 inches under pipe haunch and to springline (midpoint) of pipe to provide side support.
   1) Prevent vertical and lateral displacement of pipe from proper alignment.
   2) Compact soils using hand operated tamping devices or other methods to 95 percent of maximum dry density in accordance with AASHTO T-180.
   3) Ensure thorough compaction of fill under haunches of pipe.

E. Initial Backfill: Carefully place and compact backfill material in thin level lifts not to exceed 6 inches in thickness from springline to a height of at least one foot above pipe.
   1) Place fill evenly on both sides of pipe for full length of pipe.
   2) Compact soils using hand operated tamping devices or other methods to 95 percent of maximum dry density in accordance with AASHTO T-180.
   3) Ensure thorough compaction of the fill.

F. Final Backfill: Backfill remainder of the trench, except beneath pavement, structures, or other items as specified herein, with native satisfactory material placed in thin level lifts not to exceed 12 inches in thickness and compacted to 90 percent of maximum dry density in accordance with AASHTO T-180.

1) Place fill from top of initial backfill to lines and grades shown on construction documents or existing grade but not less than 12 inches clear.

G. Final Backfill under Roadways and Structures: Place suitable soils, either native or borrow, in thin level lifts not to exceed 12 inches in thickness and compact to 95 percent of maximum dry density in accordance with AASHTO T180.
   1) Place fill from top of initial backfill to bottom of base or existing grade.
   2) For utilities installed after subgrade preparation, prepare subgrade in accordance with requirements for pavement section at no additional compensation.
   3) Do not use unsuitable soils.

H. Final Backfill under Appurtenances: After manhole, catch-basin, inlet or similar structure has been constructed and concrete has been allowed to cure for three days minimum, place fill in manner that structure will not be damaged by shock of falling earth.
   1) Deposit and compact material as specified for final backfill or final backfill under roadways and structures, and place in manner to prevent eccentric loading and excessive stress on structure.

I. Unsuitable Material: In locations where native material is unsuitable soils, notify Engineer for directions prior to backfill operations. Final backfill shall consist of native unsuitable soils or suitable soils as directed by Engineer. Replacement of native unsuitable soils with suitable soils shall be paid for as specified herein, except, in locations where removal and replacement of unsuitable soils is covered and paid for under other sections no additional compensation will be due.

**3.7 FINISHING**

A. Areas outside limits of other work: Finish grade disturbed areas to provide a smooth, uniform and attractive surface free of exposed roots and debris and then stabilize in accordance with Section 32 92 19 -Grassing by Seeding or repair pavement in accordance with details contained on drawings or to match existing.

**3.8 DISPOSAL OF EXCESS AND WASTE MATERIALS -** Comply with requirements of Section 30 00 00.

**3.9 TESTING AND INSPECTION REQUIREMENTS -** comply with requirements of Section 30 00 00.

## 4. MEASUREMENT AND PAYMENT

**4.1 GENERAL**

A. The contract unit price shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals necessary for completion in every detail in accordance with plans and specifications.
   1) There will be no separate payment for work covered by this section except as contained herein, and all costs in connection therewith shall be included in the contract price for item or structure to which it pertains.
   2) Bedding: No separate payment will be made for this item.
   3) Replacement of unsuitable or unstable material with suitable material in the bedding, haunching and initial backfill areas: No separate payment will be made for this item.
   4) Unsuitable materials in the final backfill zone: The contract unit price shall be compensation in full for one cubic yard, in-place, of suitable fill material. Measurement shall be as computed by the Engineer. When a separate unit price is not available for this item, at discretion of Engineer, a unit price equal to one-half unit price for removal and replacement of unsuitable material will be used.

**END OF SECTION 31 23 16**

# SECTION 313116 - TERMITE CONTROL

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Soil treatment with termiticide..

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include the EPA-Registered Label for termiticide products.

### 1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Soil Treatment Application Report: Include the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Termiticide brand name and manufacturer.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes used, and rates of application.
6. Areas of application.
7. Water source for application.

C. Warranties: Sample of special warranties.

### 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 and who employs workers trained and approved by manufacturer to install manufacturer's products.

B. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.

### 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.

B. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.6 WARRANTY

A. Soil Treatment 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: Three years from date of Substantial Completion.**

1.7 MAINTENANCE SERVICE

**A. Continuing Service: Beginning at Substantial Completion, provide 12 months'continuing service including monitoring, inspection, and re-treatment for occurrences of termite activity. Provide a standard continuing service agreement. State services, obligations, conditions, terms for agreement period, and terms for future renewal options.**

PART 2 - PRODUCTS

2.1 SOIL TREATMENT

A. Termiticide: Provide an Registered termiticide, complying with requirements of authorities having jurisdiction,including the FLORIDA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES in compliance with Florida Statues, Chapter 487, 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. Products: As listed on the Florida Department of Agriculture and Consumer Services website.

   http://www.flaes.org/pdf/termiticidesregisteredinflorida.pdf

2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than three years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 APPLICATION, GENERAL

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

## 3.2 APPLYING SOIL TREATMENT

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for[ moisture content of soil per termiticide label requirements,] interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

B. Proceed with application only after unsatisfactory conditions have been corrected.

C. 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.

D. 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 and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
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; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
3. Masonry: Treat voids.
4. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.

E. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

F. 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.

G. Post warning signs in areas of application.

H. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 313116

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# SECTION 32 05 23
# CONCRETE FOR SITE WORK

## 1. GENERAL

### 1.1 DESCRIPTION OF WORK
A. The work included under this Section consists of furnishing all materials, forms, transportation and equipment, and performing all necessary labor to construct plain and reinforced concrete items shown or indicated on the Civil Drawings, specified in applicable Division-30 specifications, or incidental to proper execution of site work.

### 1.2 RELATED WORK
A. Section 30 00 00 - General Site Work Requirements.
B. Section 31 20 00 - Earthwork.
C. Section 31 23 16.13 - Earthwork for Utilities.
D. Section 32 13 13 - Concrete Walks, Curbs, Gutters, and Pavement.

### 1.3 REFERENCES
A. FDOT Section 345
B. ACI 301 “Specifications for Structural Concrete for Buildings”
C. ACI 318 “Building Code Requirements for Reinforced Concrete”
D. Concrete Reinforcing Steel Institute, “Manual of Standard Practice”

### 1.4 SUBMITTALS .comply with requirements of Section 30 00 00

### 1.5 QUALITY ASSURANCE .comply with requirements of Section 30 00 00.

## 2. PRODUCTS

### 2.1 FORM MATERIALS
A. Forms for Exposed Finish Concrete: Construct with plywood, metal, metal-framed plywood-faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces.
   1) Furnish in largest practicable sizes to minimize number of joints.
   2) Provide sufficient strength to withstand all pressures due to newly placed concrete and temperature changes.
B. Forms for Unexposed Finish Concrete: Form concrete surfaces, which will be unexposed in finished structures, with plywood, lumber, metal or other acceptable material.
C. Provide lumber dressed on at least two edges and one side for tight fit.
D. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces requiring bond or adhesion, nor impede wetting of surfaces to be cured with water or curing compound.

### 2.2 REINFORCING MATERIALS
A. Reinforcing Bar (Rebar): ASTM A 615 of domestic source and manufacture.
   1) Provide Grade 60, except where otherwise shown, for bar numbers 3 to 18.
B. Steel Wire: ASTM A82, plain, cold-drawn, steel.
C. Welded Wire Fabric (WWF): ASTM A 185, welded steel wire fabric.
D. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place.
   1) Use wire bar type supports complying with CRSI recommendations, unless otherwise specified.
   2) Wood, brick and other devices will not be acceptable.
E. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are hot-dip galvanized, or plastic protected, or stainless steel protected.

## 2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150.
   1) Type I Cement - Unless otherwise specified.
   2) Type II Cement-For construction of sanitary sewer manholes, wetwells, and pump stations.
B. Use only one brand of cement throughout project, unless otherwise acceptable to Engineer.
   1) Fly ash will not be permitted in lieu of cement.
C. Aggregates: ASTM C33, and as herein specified.
   1) Provide aggregates from a single source for all exposed concrete.
   2) Local aggregates not complying but shown by special test or service to produce concrete of adequate strength and durability may be used when acceptable to Engineer.
D. Maximum Aggregate Size: Not larger than one-fifth of narrowest dimension between sides of forms, one-third of depth of slabs, nor three-fourths of minimum clear spacing between individual reinforcing bars or bundles of bars.
E. Fine Aggregate: Conform to the requirements of FDOT Section 902.
F. Coarse Aggregate: Conform to the requirements of FDOT Section 901.
   1) Slag is not allowed.
   2) Gradation shall be grade 5 or grade 9 as approved by Engineer.
G. Water: From a potable water supply, fresh, clean and free from injurious amounts of oil, acid, alkali or organic matter.
H. Admixtures: Admixtures shall not be used except by specific approval of Engineer.
I. Grout: Material for grouting column base plates, anchor bolts, reinforcing bars, pipe sleeves and pump base plates shall be premixed non-shrink type equal to Sauereisen F-100 Level-Fill grout.
   1) Mix and place as recommended by the manufacturer.
   2) Machinery set on grout pads shall not be operated until grout has cured for at least 24 hours.
J. Grout for pointing and patching shall consist of cement and fine aggregate mixed in proportions used in concrete and a minimum amount of water to produce a workable grout.

## 2.4 CLASSIFICATION AND STRENGTH OF CONCRETE

A. Class and Minimum Strength Requirements: Unless noted otherwise on plans or in applicable Division-30 specifications, class and minimum strength requirements for concrete shall be as tabulated below.
   1) Use Class B concrete unless noted otherwise.
B. Strength Requirements: Class and strength to meet minimum compressive strength requirements at age of 7 and 28 days as shown in following table. Compressive strengths to be determined by standard laboratory cylinder tests in accordance with ASTM C 31 and C 39.

COMPRESSIVE STRENGTH IN POUNDS PER SQUARE INCH:

| Class | For Design Purposes | Cylinder Strength 7 Days | Cylinder Strength 28 Days |
|---|---|---|---|
| A | 4,000 | 2,500 | 3,700 |
| B | 3,200 | 1,800 | 3,000 |
| C | 2,700 | 1,500 | 2,500 |

## 2.5 PROPERTIES AND DESIGN OF CONCRETE MIX

A. Water Cement Contents and Slumps: Use lowest slump possible consistent with placement. Use low slump concrete for footings, curb, curb and gutter, sidewalks and slabs on grade. Use medium slump concrete for walls, columns and suspended slabs. Do not use maximum slump concrete except by permission of Engineer. Concrete shall conform to limits specified in following schedule:

CLASS OF CONCRETE

| CLASS | A | B | C |
|---|---|---|---|
| Minimum Cement Content Bags Per Cubic Yard: | 6.5 | 5.25 | 4.5 |
| Maximum Water/Cement Ratio Gallons Per Bag: | 6.5 | 7 | 7.75 |
| Maximum Slump: | >5” | >5” | >6” |
| Medium Slump: | 4”-5” | 4”-5” | 5”-6” |
| Minimum Slump: | 2”-3” | 0-3"** | 3-4" |

** - Zero slump concrete is allowed for slip-form payers only.

**2.6 CONCRETE MIXING**

A. Equipment: Ready-mix with equipment conforming to applicable requirements of ASTM C 94.

B. Measurement: Provide equipment necessary to positively determine and control actual amounts of all materials entering concrete. Measure materials by weight, except water may be measured by volume.

1) One bag of cement will be considered as 94 pounds in weight.

# 3. EXECUTION

**3.1 CONCRETE GENERAL:**

A. Secure reinforcement in position for inspection and approval before placing concrete.

B. Do not allow runways for transporting concrete to rest on reinforcing steel.

C. Reject and remove from site concrete not placed within 90 minutes from time mixing is started.

D. Deposit concrete as nearly as practicable in final position.

E. Do not allow concrete to drop freely more than four feet.

F. Place concrete in daylight and, excepting seal concrete, place in dry unless otherwise authorized by Engineer.

**3.2 COMPACTION:**

A. Use internal vibrating equipment, supplemented by hand rodding and tamping as required.

B. Do not use vibrators to move concrete laterally inside forms.

C. Internal vibrators shall maintain a speed of at least 5,000 impulses per minute when submerged in concrete.

D. Duration of vibration shall be limited to time necessary to produce satisfactory consolidation without causing segregation.

E. Move vibrator constantly and place in each specific spot only once.

**3.3 BONDING AGAINST SET CONCRETE:**

A. Thoroughly clean surfaces of set concrete to expose coarse aggregate.

B. Surfaces to be free of laitance, coating, foreign matter and loose particles.

C. Retighten forms.

D. Cleaned surfaces may be moist, but without free water when concrete is placed.

**3.4 FIELD CONTROL AND TESTING**

A. General: Quality of concrete as to conformance is responsibility of Contractor until accepted in place and verified by final cylinder tests.

1) Schedule field testing.

B. Tests: Testing lab to obtain standard laboratory compressive test cylinders when concrete is discharged from mixer.

1) Obtain set of three cylinders for each 50 cubic yards, or fraction thereof, placed each day, for each type of concrete.

2) Cure cylinders under laboratory conditions and test at 7 (one each) and 28 (two each) days of age.

C. Slump Tests: Testing lab to make slump tests of Class A and Class B concrete as it is discharged from mixer.

1) Perform tests at recurrence interval established by Testing Laboratory or for each set of test cylinders.
2) Slump tests may be made on any batch and failure to meet requirements will be cause for rejection of batch.

D. Reports: Label reports to identify portions of project into which materials are placed.

## 3.5 PROTECTION FOR REINFORCEMENT

A. Provide following minimum concrete cover over reinforcement

MINIMUM COVER IN INCHES.

| | |
|---|---|
| Concrete cast against and permanently exposed to earth | 3 |
| Concrete exposed to earth or weather (#6 through #18 bars). | 2 |
| Concrete exposed to earth or weather #5 bar, W31 or D31 wire, and smaller. | 1 1/2 |

## 3.6 REINFORCING

A. Bar Supports for Reinforcing Steel: Furnish supports to meet cover requirements contained herein or noted.
1) Furnish Hy-chairs for bent or top bars in solid slabs.
2) Maximum support spacing to be 100 times bar diameter.
3) Distance from end of bar to 1st chair not to exceed 25 times bar diameter.

B. Accurately fabricate reinforcement in accordance with CRSI Manual of Standard Practice.

C. Placing: Accurately and securely position in forms.
1) Reinforcement to be clean, free of rust, scale, dust, dirt, paint, oil or other foreign material.
2) Wire wrap or otherwise fasten steel at intersections and provide adequate support. Welding is not allowed.
3) Adjacent to earth, place bar supports on precast concrete pads compressed into subgrade.

D. Splicing of Reinforcement: Lap bars at splices a minimum of 24 bar diameters, unless noted or directed otherwise, and rigidly wire or clamp.
1) Minimize number of splices.
2) Place splices at points of minimum stress.

E. Wire Fabric:
1) Flatten prior to placement.
2) Overlap one full space of mesh at ends and edges and securely fasten.
3) Provide necessary supports to maintain fabric at proper location in concrete.
4) Fabric shall not cross expansion joints.

## 3.7 EMBEDDED ITEMS

A. General: Work may include embedment of pipes, inserts and other metal objects into concrete as shown, specified or ordered.
1) Firmly and securely fasten items in place prior to placement of concrete.
2) Protect items from being displaced, broken or deformed.
3) Items to be clean, free of rust, scale, dust, dirt, paint, oil or other foreign material.
4) Do not embed wood in concrete.
5) Tightly pack concrete around pipes and other metal work to prevent leakage and to provide prefect adhesion.
6) Protect pipes, conduits and open items from filling with concrete.

## 3.8 FORMS

A. General: Build true to line and grade, mortar tight and rigid to prevent displacement or sagging between supports.
1) Provide adequate supports and shoring.
2) Forms for permanently exposed surfaces to be smooth and free from irregularities, dents, sags or holes.
3) Bolts and rods for internal ties to be arranged such that upon removal metal will be not less than 1 1/2 inches from any concrete surface.
4) Remove form ties immediately after removal of forms and plug holes with grout within 24 hours

after removal and keep damp for four days to prevent shrinking.
5) Wire tying of forms is not permitted.
6) Construct forms for removal without hammering or prying against concrete.
7) Place suitable moldings to bevel or round exposed edges, at expansion joints, or other points to be left exposed, as may be required.

B. Coating: Prior to placement of reinforcement or concrete, coat exposed surfaces. Unexposed surfaces may be thoroughly wetted in lieu of oiling prior to placement of concrete.

C. Removal: Do not remove forms and/or form supports until concrete has obtained sufficient strength to support itself and any live loads it may be subjected to.

**3.9 CURING**

A. General: All concrete, including gunite, shall be water cured by covering with double thickness of burlap, cotton mats or other approved material kept thoroughly saturated with water.
1) Keep forms wet until removed.
2) Cure for a period of seven days for normal Portland cement or four days for high early strength cement.
3) Concrete poured in dry shall not be submerged until it has attained sufficient strength to adequately sustain stresses involved, nor shall it be subjected to flowing water for four days.
4) Begin curing of gunite as soon as possible without damaging surfaces, but not later than two hours after placing.

**3.10 FINISHES**

A. General: Power or hand float slabs to a true and even finish in a manner that will not bring excess fines to surface.
1) Consistency of the concrete shall be such that water does not accumulate at surface.
2) Float with wood or steel float and steel troweled to a smooth finish.
3) Troweling shall be minimum necessary to obtain a smooth, dense surface and shall not be done until mortar has hardened sufficiently to prevent excess fine material from being worked to surface.
4) Broom finish surfaces subject to pedestrian and vehicular traffic by lightly brushing with a push broom to produce a non-slip surface.

B. Repairs: As soon as forms can safely be removed, all irregular projections shall be chipped off flush with concrete and all voids produced by spacers or any honeycombing shall be pointed up with grout and troweled flush with concrete surface.
1) Honeycombing shall be cut out to expose a sound concrete surface prior to pointing.
2) Mortar pointing or parching is confined to repair of small defects in relatively green concrete. Where, in opinion of Engineer, substantial repairs are required, defective concrete shall be cut out to sound concrete and repaired with gunite or concrete or removed and reconstructed as directed.

**3.11 QUALITY CONTROL TESTING DURING CONSTRUCTION**

A. The Owner will employ a testing laboratory to perform following tests and to submit test reports.
1) Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
2) Slump: ASTM C 143.
3) Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231 pressure for normal weight concrete; one for each set of cylinders.
4) Compression Test Specimen: ASTM C 31; mold and store for laboratory cured test specimens except when field-cure test specimens required.
5) Compressive Strength Tests: ASTM C 39.

B. Engineer may waive strength test when total quantity of a given class of concrete is less than 50 cubic yards.

C. Additional Tests: Testing service to make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained as directed by Engineer. Obtain test samples by cored cylinders complying with ASTM C 42, or other methods as directed. Contractor shall pay for such tests and any additional testing as may be required, when unacceptable concrete is verified.

# 4. MEASUREMENT AND PAYMENT

## 4.1 GENERAL:

A. No separate payment will be made for work covered by this section and all costs in connection therewith shall be included in contract price for item or structure to which it pertains.

**END OF SECTION 32 05 23**

# SECTION 32 13 13
# CONCRETE WALKS, CURBS, GUTTERS AND PAVEMENT

## 1. GENERAL

### 1.1 DESCRIPTION OF WORK
A. Extent of work is indicated on drawings and includes but is not limited to:
B. Curb.
C. Curb and gutter.
D. Valley gutter.
E. Sidewalks.
F. Concrete Pavement.

### 1.2 RELATED WORK
A. Section 30 00 00 - General Site Work Requirements
B. Section 31 20 00 - Earthwork
C. Section 32 05 23 - Concrete for Site Work or other Division-03 Sections.
D. Section 32 12 16 - Asphaltic Concrete Pavement

**1.3 SUBMITTALS** - comply with requirements of Section 30 00 00.

**1.4 QUALITY ASSURANCE** - comply with requirements of Section 30 00 00.

## 2. PRODUCTS

### 2.1 MATERIALS
A. Forms: Comply with requirements of Section 32 05 23 or other Division-03 Sections.
B. Welded Wire Fabric (WWF): Comply with requirements of Section 32 05 23 or other Division-03 Sections.
C. Reinforcing Bars: Comply with requirements of Section 32 05 23 or other Division-03 Sections.
D. Concrete Materials: Comply with requirements of Section 32 05 23 or other Division-03 Sections.
   1) Concrete pavement shall be Class-A concrete in accordance with Section 32 05 23 and reinforced with Forta CR fiber reinforcement, or approved equal, with fiber length in accordance with manufacturer's recommendations.
E. Preformed Joint Filler (PJF): Product to meet requirements of FDOT Section 932.
F. Joint Sealer for Pavement and Structures: Product to meet requirements of FDOT Section 932.

## 3. EXECUTION

### 3.1 INSPECTION
A. Examine areas where items are to be installed and notify Engineer of unsatisfactory conditions.
   1) Do not proceed with work until unsatisfactory conditions have been corrected.

### 3.2 SURFACE PREPARATION:
A. Prepare in accordance with applicable Division-30 specifications.
   1) Remove loose materials from compacted surface immediately before placing concrete.
B. Proof-roll concrete pavement subbase surface to check for unstable and yielding areas.
   1) Do not begin work until unsatisfactory conditions have been corrected.

### 3.3 FORM CONSTRUCTION:
A. Comply with requirements of Section 32 05 23 or other Division-03 Sections.
B. Check completed formwork for grade alignment to following tolerances:
   1) Top of forms not more than 1/8 inch in 10 feet.
   2) Vertical face on longitudinal axis not more than 1/4 inch in 10 feet.
C. Clean forms after each use, and coat as often as required to ensure separation from concrete without

damage.

3.4 **REINFORCEMENT** - Comply with requirements of Section 32 05 23 or other Division-03 Sections.

**3.5 CONCRETE PLACEMENT**

A. General: Comply with requirements of Section 32 05 23 or other Division-03 Sections and as herein specified.
B. Do not place concrete until subbase and forms have been checked for line and grade.
C. Moisten subbase if required to provide a uniform dampened condition at time concrete is placed.
D. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
E. Deposit and spread concrete as far as practical in a continuous operation between transverse joints. If interrupted for more than 1/2 hour, place a construction joint.

**3.6 JOINTS:**

A. General: Construct expansion, weakened-plane (contraction), and construction joints true-to-line with face perpendicular to surface of concrete, unless otherwise indicated.
   1) Construct transverse joints at right angles to centerline or longitudinal direction, unless otherwise indicated.
   2) When joining existing structures, place transverse joints to align with previously placed joints.
B. Weakened-Plane (Contraction Joints): Provide transverse and longitudinal joints in accordance with spacing requirements contained herein and details shown on drawings.
   1) Joints may be tooled, sawed, or formed by use of an insert and shall be as follows unless dimensioned on drawings and include sealant reservoir where required.
   2) Construct with minimum depth equal to 1/4 concrete thickness and maximum width of 1/4 inch.
   3) Tooled Joints: Form in fresh concrete by grooving top portion with recommended cutting tool and finishing edges with a jointer.
   4) Sawed Joints: Form using powered saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut as soon as surface will not be torn, abraded, or otherwise damaged by cutting action.
C. Construction Joints: Provide transverse and longitudinal joints in accordance with spacing requirements contained herein and details shown on drawings.
   1) Place construction joints at end of all pours and at locations where placement operations are stopped for a period of more than 1/2 hour, except where such pours terminate at expansion joints.
   2) Use standard metal key-way-section forms when details not shown on drawings.
D. Expansion Joints: Provide transverse and longitudinal joints in accordance with spacing requirements contained herein and details shown on drawings.
   1) Provide premolded joint filler for expansion joints at following locations:
      (a) At concrete pavement abutting concrete curbs, catch basins, manholes, inlets, structures, walks and other fixed objects, and at intersections of travel lanes unless otherwise indicated.
      (b) For sidewalks provide ½ inch joints at locations shown in details.
      (c) For curbs and gutters provide ½ inch joints at 500 feet intervals, ends of runs, beginning, middle and end of curved sections.
   2) Doweled joints are required only at locations of intersections of concrete pavement where vehicular traffic will cross the joint such as roadway intersections.
   3) Construct in accordance with details shown on drawings or as follows when not shown.
      (a) Extend joint fillers full-width and depth of joint less depth of sealant reservoir where required.
      (b) If no joint sealer, place top of joint filler flush with finish concrete surface.
      (c) 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.
      (d) Protect top edge of joint filler during concrete placement with a metal cap or other temporary material. Remove protection after concrete has been placed on both sides of joint.
E. Joint Spacing: Unless noted otherwise, joint spacing shall be as follows:
   1) Curbs and Gutters: Comply with requirements of FDOT Section 520.
   2) Sidewalks: Comply with details contained in construction drawings.
   3) Concrete Pavement:
      (a) Longitudinal and transverse joint spacing to be not more than 15 feet in any direction.
      (b) On radius sections, maximum joint spacing to be 12 feet as measured along the longest edge

of curve.

(c) Do not use joint spacing of less than 4 feet.

F. Concrete pavement joint patterns to be at discretion of Contractor in accordance with Portland Cement Association (PCA) publication PA017.01P, "Concrete Parking Areas" and following publications. Comply with following:
   1) PCA PA0I7.01P, "Concrete Parking Areas".
   2) PCA IS059.03P, "Joint Design for Concrete Highway and Street Pavements".
   3) PCA IS211.01P, "Concrete Streets: Typical Pavement Sections and Jointing Details".
   4) PCA IS119.02P "Suggested Specifications for Construction of Concrete Streets".
   5) PCA MS152.01P "Typical Sections And Details"
   6) Concrete Institute of Florida, "Parking Area Specifications".

**3.7 SEALANT RESERVOIRS**

A. General: Construct sealant reservoirs as part of joint construction for joints located within concrete pavement subject to vehicular traffic and other locations as shown on drawings.
B. Unless noted otherwise, sealant reservoirs may be tooled, sawed or formed using inserts and shall be to dimensions shown on drawings.

**3.8 JOINT SEALANT**

A. General: Seal joints within concrete pavement subject to vehicular traffic and other locations as shown on drawings.
B. Comply with requirements of FDOT Section 932.

**3.9 CONCRETE FINISHING:**

A. After striking-off and consolidating concrete, smooth surface by screeding and floating
   1) Use hand methods when mechanical floating is not possible.
   2) Finish to a uniform texture.
B. After floating, test surface for trueness with 10' straightedge, distribute concrete as required to remove surface irregularities, and refloat as required to provide a continuous smooth finish.
C. Work edges of slabs, gutters, top edge of back of curb and formed joints with an edging tool, and round to 1/2" radius, unless otherwise indicated. Eliminate any tool marks on concrete surface.
D. After completion of floating and when excess moisture or surface sheen has disappeared, complete surface finishing, as follows:
   1) Broom finish by drawing a fine-hair broom across concrete surface, perpendicular to line of traffic. Repeat operation if required to provide a fine line texture acceptable to Engineer.
   2) On inclined slab surfaces, provide a coarse, non-slip finish by scoring surface with a stiff-bristled broom, perpendicular to line of traffic.
E. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point-up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by Engineer.

**3.10 CURING:**

A. Protect and cure finished concrete paving, complying with requirements of applicable Division-30 or Division-03 specifications. Use moist-curing methods for initial curing whenever possible.

**3.11 REPAIRS AND PROTECTIONS:**

A. Repair or replace broken or defective concrete, as directed by Engineer.
B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement.
   1) When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
C. Sweep concrete pavement and wash free of stains, discoloration, dirt and other foreign material just prior to final inspection.

3.12 **TESTING AND INSPECTION REQUIREMENTS** - comply with requirements of Section 30 00 00 and Section 32 05 23.

**3.13 CONCRETE PAVEMENT ACCEPTANCE TESTING**

A. Acceptance testing to consist of one pass of standard 10-foot rolling straightedge operated while pavement is plastic.
   1) Upon sufficient hardening to walk on concrete, test for irregularities exceeding 1/8 inch using straightedge.
   2) Testing and correction to be in accordance with FDOT Specification 350.
B. At option of Owner, flood with water and inspect for ponding.

# 4. MEASUREMENT AND PAYMENT

## 4.1 GENERAL

A. The contract unit price shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals necessary for completion in every detail in accordance with plans and specifications.
   1) There will be no separate payment for clean up and restoration of property, or other items under this section unless specifically identified on the proposal, bid form, or contract.

**END OF SECTION 32 13 13**

# SECTION 328400 PLANTING IRRIGATION

## 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. Piping.
2. Manual valves.
3. Automatic control valves.
4. Miscellaneous piping specialties.
5. Sprinklers.
6. Drip irrigation specialties.
7. Controllers.
8. Boxes for automatic control valves.

### 1.3 DEFINITIONS

A. Circuit Piping: Downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.

B. Drain Piping: Downstream from circuit-piping drain valves. Piping is not under pressure.

C. Main Piping: Downstream from point of connection to water distribution piping to and including control valves. Piping is under water-distribution-system pressure.

D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

### 1.4 PERFORMANCE REQUIREMENTS

A. Irrigation zone control shall be automatic operation with controller valves.

B. Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent irrigation coverage of areas indicated.

C. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:

1. Irrigation Main Piping: **200 psig**
2. Circuit Piping: **150 psig**

## 1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics and furnished specialties and accessories.

B. Wiring Diagrams: for power, signal, and control wiring.

C. Delegated-Design Submittal: For irrigation systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional responsible for their preparation.

## 1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Irrigation systems, drawn to scale, on which components are shown and coordinated with each other, using input from Installers of the items involved. Also include adjustments necessary to avoid plantings and obstructions such as signs and light standards.

B. Qualification Data: For qualified Installer.

C. Zoning Chart: Show each irrigation zone and its control valve.

D. Controller Timing Schedule: Indicate timing settings for each automatic controller zone.

E. Field quality-control reports.

## 1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sprinklers, drip, controllers, and automatic control valves to include in operation and maintenance manuals.

## 1.8 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers that include a certified irrigation designer qualified by The Irrigation Association or Professional Class member of the American Society of Irrigation Consultants

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.10 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Comply with requirements in the piping schedule for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

B. PVC Pipe: ASTM D 1785, PVC 1120 compound, Schedules 40 and 80.

1. PVC Socket Fittings: ASTM D 2466, Schedules 40 and 80.
2. PVC Threaded Fittings: ASTM D 2464, Schedule 80.
3. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket ends.

C. PVC Pipe, Pressure Rated: ASTM D 2241, PVC 1120 compound, SDR 21 and SDR 26.

1. PVC Socket Fittings: ASTM D 2467, Schedule 80.
2. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket or threaded ends.

2.2 PIPING JOINING MATERIALS

A. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 6q56.

B. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.3 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

## 2.4 MANUAL VALVES

A. Plastic Threaded Ball Valves:

1. Description:
   a. Standard: MSS SP-122.
   b. Pressure Rating: 150 psig
   c. Body Material: PVC.
   d. Type: Union.
   e. End Connections: Socket or threaded.
   f. Port: Full.

## 2.5 AUTOMATIC CONTROL VALVES

A. Plastic Automatic Control Valve

1. General Information
   a. Provide valve as per the specification.

2. Valve
   a. Irrigation valve specifications include but are not limited to:
      1) The valve body and bonnet shall be constructed of heavy-duty and ultra-violet resistant plastic.
      2) The bonnet shall be assembled to the body using multi-drive screws for use with flathead, Phillips, or hexagonal tools.
      3) Shall possess a water tight seal between the body and bonnet.
      4) Shall be a normally closed, forward flow design.
      5) Shall have a filtered pilot flow to resist debris and clogging.
      6) Shall be slow closing to prevent water hammer from causing subsequent system damage.
      7) Shall have a Ø1 inch NPT globe and angle inlet as well as a Ø1 inch NPT outlet.
      8) Shall have a manual internal bleed capability to operate the valve without allowing water into the valve box.
      9) Shall have a non-rising flow control handle to adjust water flow as needed.
      10) Shall include a 24 VAC 50/60 Hz solenoid capable of 2-wire operation.
         a) Inrush current: 0.41A (9.9VA) at 60Hz
         b) Holding current: 0.14A (3.43 VA) at 60Hz
      11) Operating flow rate of 2-40 gpm (7.6-151.4 l/min).
      12) Operating pressure range of 15-150 psi (1.04-10.4 bar).
      13) Water temperature: Up to 110°F (43°C).
      14) Ambient temperature: Up to 125°F (52°C).
      15) Shall accommodate an optional field-installed pressure regulating dial.
      16) Shall accept an optional latching solenoid for use with battery operated controllers.
      17) Shall be available with an optional purple flow control handle for use with non-potable water applications.
      18) Shall have a heavy-duty stainless steel spring for positive diaphragm closure.

## 2.6 SPRINKLERS

1. Rotors
   a. designed to provide uniform coverage over entire area of spray shown on drawings at available water pressure or as follows:
      1) Rotor for shrub or groundcover (21-40 feet) spacing: maximum 30-40 psi.
2. Pop-Up Spray
   a. Rotor for shrub or small turf areas (8-17 feet) spacing: maximum 30-40 psi. Irrigation rotor specifications include but are not limited to:
      1) The rotor body, stem and nozzle, shall be constructed of heavy-duty and ultra-violet resistant plastic.
         a) Shall have a heavy-duty stainless steel retract spring for positive pop-down.
      2) Shall have integrated seals and method for clearing debris.
         a) Oversized pressure activated wiper seal prevents leaks and protects internals from debris.
         b) Precision controlled flush at pop-down to clear debris from the unit, to assure positive stem retraction in all soil types.
         c) Ported arc adjustment screw to clear debris from unit at pop-down
      3) Shall have a slip clutch installation feature to allow easy arc alignment.
      4) Non-reversing 360° full arc rotation.
      5) 7.38 inch body height; 4.0 inch and 12 inch pop-up height (measured to center of nozzle).
      6) Operating range of 8 to 25 feet.
      7) Operating pressure range of 5 to 55 psi.
      8) Shall have a precipitation rate of 0.20 to 1.50 in/hr.
      9) Shall include a green cover and a flow shut-off valve in the rotor head.
      10) Exposed surface diameter shall measure 1.5 inch.
      11) Shall include Ø3/4 inch NPT female threaded bottom inlet.
      12) Shall include a nozzle tree containing twelve nozzles with indicated flow rates from 0.76 to 9.63 gpm and an exit trajectory of 10-25°.
      13) All rotor body components shall be removable from the top without special tools in order to provide quick and easy flushing and maintenance of the sprinkler.
      14) Shall include slot in cover for use of a pull up tool for ease of nozzle installation and replacement.
      15) Shall include nozzle retention screw that may also be used to reduce spray radius by 25%.
      16) Shall have a filter screen in the stem to protect the drive from clogging and to simplify removal for cleaning and flushing the system.
      17) Shall utilize nozzles designed to deliver even distribution over the entire radius including large wind resistant droplets and gentle close-in-watering.

## 2.7 CONTROLLERS

A. Description:

1. The controller shall be a full-featured, commercial-industrial product for the purpose of irrigation operation, management, and monitoring of control valves and sensors. The

controller shall be of a modular design that is provided with a standard 8-station output module. The controller shall be expandable to 12-station decoder output module controller Stations for Automatic Control Valves: Each station is variable from approximately 5 to 60 minutes. Include switch for manual or automatic operation of each station.

2. Exterior Control Enclosures: NEMA 250, Type 4, weatherproof, with locking cover and two matching keys; include provision for grounding.
   a. Body Material: Molded plastic.
   b. Mounting: Pole mounted.
3. Control Transformer: 24-V secondary, with primary fuse.
4. Depending on requirements, transformer input shall be 120 VAC, 60 Hz or 230 VAC, 50 Hz. Maximum output per station shall be 24 VAC, up to 0.56 A. Maximum output per P/MV terminal shall be 24 VAC, up to 0.56 A.
5. The controller transformer shall be equipped with an internal, self-resetting thermal circuit breaker to protect against overheating.
6. The controller transformer shall also be equipped with a ground lug for connecting to proper earth-ground hardware.
7. Station Modules
   a. Controller shall provide 12 (plastic enclosure) station output module slots Timing Device: Adjustable, 24-hour, 14-day clock, with automatic operations to skip operation any day in timer period, to operate every other day, or to operate two or more times daily.
   b. Station modules shall be secured against field wiring tension by locking levers.
   c. Using 2 wire only, the controller shall be expandable from 8 to 38 stations (plastic) and 8 to 54 stations (metal and pedestals).
   d. Using conventional station modules in conjunction with one decoder output module (model: EZ-DM), all controller configurations (plastic, metal, pedestal) shall expand up to 54 stations.
   e. Using only one decoder output module (model: EZ-DM) all controller configurations (plastic, pedestal) shall expand up to 54 stations.
   f. The controller shall have a base model capacity of 12 stations, consisting of one 8-station output module.
   g. Each station output shall supply 24 VAC, up to 0.56 A current for solenoid activation.
   h. The controller shall have self-diagnostic, electronic short circuit protection that detects a faulty circuit, continues watering the remainder of the program, and reports the faulty station via alert/notification to the user's smartphone, tablet, or computer. The built-in milliamp sensor shall constantly be measuring the current draw of each individual station.
   i. Module hardware
      1. The controller output modules shall have metal oxide varistors (MOVs) and copper induction coils on each station output circuit to help protect the microcircuitry from power surges
         i. Sensor inputs - The controller shall be equipped with two dedicated general-purpose sensor ports.
      2. The sensor inputs shall be compatible with any standard normally closed or normally open "Clik-type" sensors for automatic shutdown during rain, freeze, soil moisture, and/or wind events.

3. The sensor inputs shall also be compatible with the Rainbird Flow Meter for flow monitoring, alerts, and reporting.

k. P/MV outputs
   1. The controller shall have one built-in P/MV (24 VAC) output with a capacity of up to 0.56 A.
   2. The P/MV output shall be selectable as active or disabled per each individual station.
   3. A common wire terminal is provided on the controller's power module, and additional commons are provided on each station output module.
      a. SmartPort®
         1) The controller shall be pre-wired with a SmartPort connector for easy connection of optional wireless remote controls.
         2) For international or short-range uses, the wireless remote control shall be the Rainbird model with a useful range of up to 1,000' (330 m).
         3) For use in the United States or long-range uses, where permitted, the wireless remote shall be Rainbird model with a useful range of up to 2 mi. (3.2 km).
   4. 3.10 Wi-Fi information
      a. The controller shall be equipped with built-in Wi-Fi.
      b. Wi-Fi operation shall be 802.11 b/g/n.
      c. Wi-Fi frequency is 2.4 GHz.
      d. Security shall have the ability to auto detect and offer the following security settings: WPA2, WPA Personal, and WPA Auto.

8. Moisture Sensor: Adjustable from one to seven days, to shut off water flow during rain.
9. Wiring: UL 493, Type UF multiconductor, with solid-copper conductors; insulated cable; suitable for direct burial.
   a. Feeder-Circuit Cables: No. 12 AWG minimum, between building and controllers.
   b. Low-Voltage, Branch-Circuit Cables: No. 14 AWG minimum, between controllers and automatic control valves; color-coded different from feeder-circuit-cable jacket color; with jackets of different colors for multiple-cable installation in same trench.
   c. Splicing Materials: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint and epoxy resin moisture seal; suitable for direct burial.

## 2.8 BOXES FOR AUTOMATIC CONTROL VALVES

A. Plastic Boxes:
   1. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade.
      a. Size: As required for valves and service.
      b. Shape: Round (for gate valves) and Rectangular for control valves.
      c. Sidewall Material: PE.
      d. Cover Material: PE

B. Drainage Backfill: Cleaned gravel or crushed stone, graded from 3/4 inch minimum to 3 inches maximum.

# PART 3 - EXECUTION

## 3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

B. Install warning tape directly above pressure piping, 12 inches below finished grades, except 6 inches below subgrade under pavement and slabs.

C. Drain Pockets: Excavate to sizes indicated. Backfill with cleaned gravel or crushed stone, graded from 3/4 to 3 inches to 12 inches below grade. Cover gravel or crushed stone with sheet of asphalt-saturated felt and backfill remainder with excavated material.

D. Provide minimum cover over top of underground piping according to the following:

1. Irrigation Main Piping: Minimum depth of 36 inches below finished grade, or not less than 18 inches below average local frost depth, whichever is deeper.
2. Circuit Piping: 12 inches.
3. Drain Piping: 12 inches.
4. Sleeves: 24 inches.

## 3.2 PREPARATION

A. Set stakes to identify locations of proposed irrigation system. Obtain Architect's approval before excavation.

## 3.3 PIPING INSTALLATION

A. Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings.

B. Install piping at minimum uniform slope of 0.5 percent down toward drain valves.

C. Install piping free of sags and bends.

D. Install groups of pipes parallel to each other, spaced to permit valve servicing.

E. Install fittings for changes in direction and branch connections.

F. Install unions adjacent to valves and to final connections to other components with NPS 2 or smaller pipe connection.

G. Install underground thermoplastic piping according to ASTM D 2774 and ASTM F 690.

H. Install expansion loops in control-valve boxes for plastic piping.

I. Lay piping on solid subbase, uniformly sloped without humps or depressions.

J. Install ductile-iron piping according to AWWA C600.

K. Install PVC piping in dry weather when temperature is above 40 deg F. Allow joints to cure at least 24 hours at temperatures above 40 deg F before testing.

L. Install water regulators with shutoff valve and strainer on inlet and pressure gage on outlet. Install shutoff valve on outlet. Install aboveground or in control-valve boxes.

M. Water Hammer Arresters: Install between connection to building main and circuit valves aboveground or in control-valve boxes.

N. Install piping in sleeves under parking lots, roadways, and sidewalks.

O. Install sleeves made of Schedule 40 PVC pipe and socket fittings, and solvent-cemented joints.

P. Install transition fittings for plastic-to-metal pipe connections according to the following:
1. Underground Piping:
   a. NPS 1-1/2 and Smaller: Plastic-to-metal transition fittings.
   b. NPS 2 and Larger: AWWA transition couplings.
2. Aboveground Piping:
   a. NPS 2 and Smaller: Plastic-to-metal transition fittings.
   b. NPS 2 and Larger: Use dielectric flange kits with one plastic flange.

Q. Install dielectric fittings for dissimilar-metal pipe connections according to the following:
1. Underground Piping:
   a. NPS 2 and Smaller: Dielectric coupling or dielectric nipple.
   b. NPS 2-1/2 and Larger: Prohibited except in control-valve box.
2. Aboveground Piping:
   a. NPS 2 and Smaller: Dielectric union.
   b. NPS 2-1/2 to NPS 4: Dielectric flange.
   c. NPS 5 and Larger: Dielectric flange kit.
3. Piping in Control-Valve Boxes:
   a. NPS 2 and Smaller: Dielectric union.
   b. NPS 2-1/2 to NPS 4: Dielectric flange.
   c. NPS 5 and Larger: Dielectric flange kit.

## 3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Flanged Joints: Select rubber gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

E. Ductile-Iron Piping Gasketed Joints: Comply with AWWA C600 and AWWA M41.

F. Copper-Tubing Brazed Joints: Construct joints according to CDA's "Copper Tube Handbook," using copper-phosphorus brazing filler metal.

G. Copper-Tubing Soldered Joints: Apply ASTM B 813 water-flushable flux to tube end unless otherwise indicated. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.

H. PE Piping Fastener Joints: Join with insert fittings and bands or fasteners according to piping manufacturer's written instructions.

I. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End PE Pipe and Fittings: Use butt fusion.
2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.

J. PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Pressure Piping: Join schedule number, ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

## 3.5 VALVE INSTALLATION

A. Valves: Install in boxes for automatic control valves or aboveground between shutoff valves.

## 3.6 SPRINKLER INSTALLATION

A. Install sprinklers after hydrostatic test is completed.

B. Install sprinklers at manufacturer's recommended heights.

C. Locate part-circle sprinklers to maintain a minimum distance of 6 inches from walls and 2 inches from other boundaries unless otherwise indicated.

## 3.7 AUTOMATIC IRRIGATION-CONTROL SYSTEM INSTALLATION

A. Equipment Mounting: Install exterior freestanding controllers within manufacturer plastic cabinet.

1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished by manufacturer.
2. Install anchor bolts to elevations required for proper attachment to supported equipment per manufacturer.

B. Install control cable in same trench as irrigation piping and at least 2 inches below piping. Provide conductors of size not smaller than recommended by controller manufacturer. Install cable in separate sleeve under paved areas.

## 3.8 CONNECTIONS

A. Comply with requirements for piping specified for irrigation water supply as directed by local permitting requirements and Chapter 62-524, F.A.C., rules of Florida Department of Environmental Protection for piping, fittings, and specialties.

B. Install piping adjacent to equipment, valves, and devices to allow service and maintenance.

C. Connect wiring between controllers and automatic control valves.

## 3.9 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on each automatic controller.
1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tapes over underground piping during backfilling of trenches. See Section 312000 "Earth Moving" for warning tapes.

## 3.10 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Any irrigation product will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

## 3.11 STARTUP SERVICE

A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that controllers are installed and connected according to the Contract Documents.
3. Verify that electrical wiring installation complies with manufacturer's submittal.

## 3.12 ADJUSTING

A. Adjust settings of controllers.

B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.

C. Adjust sprinklers and devices, except those intended to be mounted aboveground, so they will be flush with finish grade.

## 3.13 CLEANING

A. Flush dirt and debris from piping before installing sprinklers and other devices.

## 3.14 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain automatic control valves and controllers.

## 3.15 PIPING SCHEDULE

A. Install components having pressure rating equal to or greater than system operating pressure.

B. Piping in control-valve boxes and aboveground may be joined with flanges or unions instead of joints indicated.

C. Underground irrigation main piping NPS 4 shall be one of the following:
1. Class 200 PVC pipe and socket fittings, and solvent-cemented joints.

D. Underground irrigation main piping, NPS 5 and larger, shall be the following:
1. Class 200 PVC pipe and socket fittings; and solvent-cemented joints.

E. Circuit piping, NPS **2** the following:
1. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.

F. Circuit piping, NPS 2-1/2 to NPS 4 shall be the following:
1. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.

G. Underground Branches and Offsets at Sprinklers and Devices: Schedule 80, PVC pipe; threaded PVC fittings; and threaded joints.
   1. Option: Plastic swing-joint assemblies, with offsets for flexible joints, manufactured for this application.

END OF SECTION 328400

# SECTION 329200 - RESTORATION

## 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 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

### 1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See “Soil Preparation (Performance Specification)" and drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

### 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for sod. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

## 1.5 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.

## 1.6 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 014000 "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

C. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways, and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

## PART 2 - PRODUCTS

### 2.1 TURFGRASS SOD

A. Turfgrass Sod: Certified, 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: Zoysia Grass 'El Toro' (Eremochloa ophiuroides).

C. 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:

### 2.2 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
   2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

   1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
   2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

### 2.3 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 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."

B. Coordinate "Placing Planting Soil" Paragraph below with Section 329113 "Soil Preparation" or Section 329115 "Soil Preparation (Performance Specification)."

C. Placing Planting Soil: Blend planting soil in place.
   1. Reduce elevation of planting soil to allow for soil thickness of sod.

D. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

E. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

F. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

### 3.3 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or

sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across slopes exceeding 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.

## 3.4 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 re-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. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering:

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 Zoysia grass to a height of 1 to 2.5 inch.

## 3.5 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
2. 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.

## 3.6 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.

## 3.7 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove non-degradable erosion-control measures after grass establishment period.

## 3.8 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: 30 days from date of Substantial Completion.

END OF SECTION 329200

# SECTION 32 92 19
# GRASSING (BY SEEDING)

## 1. GENERAL

### 1.1 DESCRIPTION OF WORK
A. Extent of work is indicated on drawings and includes but is not limited to:
   1) Ground preparation.
   2) Fertilization.
   3) Seeding.
   4) Hydro-seeding
   5) Rolling.
   6) Watering.

### 1.2 RELATED WORK
A. Section 30 00 00 - General Site Work Requirements
B. Section 31 20 00 - Earthwork
C. Section 31 23 16.13 - Earthwork for Utilities
D. Section 31 25 00 - Erosion Control and Environmental Protection

**1.3 SUBMITTALS -** comply with requirements of Section 30 00 00.

**1.4 QUALITY ASSURANCE - comply with requirements of Section 30 00 00.**

## 2. PRODUCTS

**2.1 GRASS SEED -** Comply with requirements of FDOT Section 570 and Section 981.

**2.2 HYDRO-SEED -** Product meeting requirements of FDOT and approved by Engineer.

**2.3 MULCH -** Comply with requirements of FDOT Section 570 and Section 981.

**2.4 FERTILIZER -** Comply with requirements of FDOT Section 570 and Section 982.
A. Use Type I fertilizer unless directed otherwise.

**2.5 DOLOMITIC LIME -** Comply with requirements of FDOT Section 570 and Section 982.

**2.6 WATER -** Comply with requirements of FDOT Section 570 and Section 983.

## 3. EXECUTION

**3.1 EQUIPMENT -** Comply with requirements of FDOT Section 570.

### 3.2 SEED MIX
A. Seed mixtures and applicability shall be in accordance with following table. Mixtures and applicability of seed types not included in table shall be determined by Engineer on a case by case basis.

A. The 18 inch planting mixture, when required, shall consist of a thorough mixture of 40% peat and 60% sand. The peat shall be Florihome peat or equivalent and the sand shall be clean and free from debris of any kind.

2.06 FERTILIZER

A. Fertilizer shall be pelletized 13-13-13, or approved equal.

**PART 3 - EXECUTION**

3.01 LANDSCAPING RESTORATION

A. Lawn Areas: Any lawn area affected by the required work shall be restored to a condition equal or better than the conditions existing before the commencement of work.

B. Balled Plants: Plants where required shall be adequately balled with firm natural balls of soil, sized as set forth in "Horticultural Standards." Balls shall be firmly wrapped with burlap or equally approved strong cloth. No balled plant will be planted if the ball is cracked or broken before or during the process of planting.

C. Preparation of Plant Pits: All plant pits shall be circular in outline and have vertical sides. Tree pits shall be two feet wider than the width of the ball and one foot deeper than the depth of the ball. Shrubs that are either B&B or 3 gallons + shall have pits that are two feet wider than the width of the plant ball and 6 inches deeper than the depth of the ball. Smaller shrubs shall have pits that are at least one foot wider than the width of the plant ball and 6 inches deeper than the ball depth.

D. Setting Plants: All plants except as otherwise specified, shall be centered in pits. Deep planting shall be avoided and unless otherwise specified, plants shall be set at such a level that after settlement they will bear the same relation to the required grade as they have to the natural grade before being transplanted.

E. Balled and burlapped plants and palm trees shall be placed on 6 inches to 12 inches of tamped planting mixture and adjusted so as to be at the proper level. The rope and burlap shall be cut away and the burlap folded down to the bottom of the pit. Very large B&B plants shall remain wrapped until fully backfilled and then just the upper portion of the burlap shall be removed. Backfill of planting mix shall be placed halfway up the pit and then water tamped. After this water has drained away, backfill around the ball to grade and water tamp again. Finally, form a ridge of soil around the edge of the pit to form a saucer and full area three times with water.

F. Water: Water to be used initially during plant installation shall be furnished by the CONTRACTOR. The existing irrigation system, where damaged, shall be promptly repaired after the installation of the plants.

G. Options as to Methods: Any plant may be furnished container grown instead of balled if all other requirements are met.

H. Immediately before sod is placed, 8-8-8 fertilizer shall be applied at the rate of approximately 500 pounds per acre, by broadcasting and raking into the planting area.

I. Sod shall be firmly embedded by light tamping. Wherever necessary to prevent an erosion condition caused by vertical edges at the outer limits of the sodded area, the sod shall be tamped so as to produce a featheredge at the outer limits. The sod shall be kept in a moist condition after it is planted. Water shall not be applied between the hours of 8 A.M., and 4 P.M., nor when there

# SECTION 32 92 23
# SODDING

## 1. GENERAL

### 1.1 DESCRIPTION OF WORK
A. Extent of work is indicated on drawings and includes but is not limited to:
   1) Ground preparation.
   2) Fertilization.
   3) Sodding.
   4) Watering.

### 1.2 RELATED WORK
A. Section 30 00 00 - General Site Work Requirements
B. Section 31 20 00 - Earthwork
C. Section 31 23 16.13 - Earthwork for Utilities
D. Section 31 25 00 - Erosion Control and Environmental Protection

**1.3 SUBMITTALS** - Comply with requirements of Section 30 00 00

**1.4 QUALITY ASSURANCE** - Comply with requirements of Section 30 00 00.

## 2. PRODUCTS

**2.1 SOLID SOD** - Comply with requirements of FDOT Section 575 and Section 981.

**2.2 FERTILIZER** - Comply with requirements of FDOT Section 575 and Section 982.

**2.3 DOLOMITIC LIME** - Comply with requirements of FDOT Section 575 and Section 982.

**2.4 WATER -** Comply with requirements of FDOT Section 575 and Section 983.

## 3. EXECUTION

### 3.1 GENERAL
A. Use of solid sod is conditioned on the time of year, weather and soil conditions. Do not sod when time of year, weather or soil conditions are inappropriate without authorization of Engineer. During dormant periods, consult with Engineer on use of alternative stabilization method. Engineer may direct use of seed & mulch, hydroseeding, hydromulch or any stabilization methods as contained in Section 31 25 00 as an alternative to solid sod.

### 3.2 PREPARATION OF GROUND
A. Scarify or loosen area to a suitable depth then rake smooth, free from rocks or stones.
   1) Engineer may authorize elimination of ground preparation for area where the soil is sufficiently loose.
   2) Correct soft spots and inequalities in grade.
   3) Schedule inspection by Engineer upon preparation of ground.
   4) Water soil before sod placement.
   5) Comply with requirements of Section 31 25 00.

**3.3 FERTILIZATION** - Comply with requirements of FDOT Section 575.

### 3.4 SOD PLACEMENT
A. General: Lay sod without voids and tamp or roll to required finish grade.
   1) Broom screen topsoil over entire area.
   2) Thoroughly water sod.

A. The 18 inch planting mixture, when required, shall consist of a thorough mixture of 40% peat and 60% sand. The peat shall be Florihome peat or equivalent and the sand shall be clean and free from debris of any kind.

2.06 FERTILIZER

A. Fertilizer shall be pelletized 13-13-13, or approved equal.

**PART 3 - EXECUTION**

3.01 LANDSCAPING RESTORATION

A. Lawn Areas: Any lawn area affected by the required work shall be restored to a condition equal or better than the conditions existing before the commencement of work.

B. Balled Plants: Plants where required shall be adequately balled with firm natural balls of soil, sized as set forth in "Horticultural Standards." Balls shall be firmly wrapped with burlap or equally approved strong cloth. No balled plant will be planted if the ball is cracked or broken before or during the process of planting.

C. Preparation of Plant Pits: All plant pits shall be circular in outline and have vertical sides. Tree pits shall be two feet wider than the width of the ball and one foot deeper than the depth of the ball. Shrubs that are either B&B or 3 gallons + shall have pits that are two feet wider than the width of the plant ball and 6 inches deeper than the depth of the ball. Smaller shrubs shall have pits that are at least one foot wider than the width of the plant ball and 6 inches deeper than the ball depth.

D. Setting Plants: All plants except as otherwise specified, shall be centered in pits. Deep planting shall be avoided and unless otherwise specified, plants shall be set at such a level that after settlement they will bear the same relation to the required grade as they have to the natural grade before being transplanted.

E. Balled and burlapped plants and palm trees shall be placed on 6 inches to 12 inches of tamped planting mixture and adjusted so as to be at the proper level. The rope and burlap shall be cut away and the burlap folded down to the bottom of the pit. Very large B&B plants shall remain wrapped until fully backfilled and then just the upper portion of the burlap shall be removed. Backfill of planting mix shall be placed halfway up the pit and then water tamped. After this water has drained away, backfill around the ball to grade and water tamp again. Finally, form a ridge of soil around the edge of the pit to form a saucer and full area three times with water.

F. Water: Water to be used initially during plant installation shall be furnished by the CONTRACTOR. The existing irrigation system, where damaged, shall be promptly repaired after the installation of the plants.

G. Options as to Methods: Any plant may be furnished container grown instead of balled if all other requirements are met.

H. Immediately before sod is placed, 8-8-8 fertilizer shall be applied at the rate of approximately 500 pounds per acre, by broadcasting and raking into the planting area.

I. Sod shall be firmly embedded by light tamping. Wherever necessary to prevent an erosion condition caused by vertical edges at the outer limits of the sodded area, the sod shall be tamped so as to produce a featheredge at the outer limits. The sod shall be kept in a moist condition after it is planted. Water shall not be applied between the hours of 8 A.M., and 4 P.M., nor when there

# SECTION 33 05 07
# DIRECTIONAL BORES

## PART 1 - GENERAL

### 1.01 DESCRIPTION OF WORK

A. The extent of directional boring is shown on the drawings.

B. The work included in this section covers the installation of carrier pipe by the directional boring (trenchless installation) method as described herein, within the limits indicated on the drawings. In general, include bore pit, pilot hole (as required), drilling fluids, carrier pipe, removal and disposal of drilling fluids and soil cuttings, soil reports as required by jurisdictional agencies beyond those already provided by the Owner, siltation and sediment control, and all other work required to install the carrier pipe as specified herein and as shown on the drawings.

C. The Contractor will furnish all labor, equipment, materials and supplies and will perform all work necessary to provide Owner with a complete, finished reclaimed water and sewer force main crossing via horizontal directional drilling.

D. The proposed profile and grade of the fiber optic conduit is the responsibility of the contractor. All existing utility locations (horizontal and vertical) within the proposed alignment shall be confirmed by the contractor prior to drilling. Contractor is responsible for any damage to the existing utilities during work.

E. The Contractor shall have an FDOT inspector on the job site for all directional bores crossing a state highway.

F. Contractor must also conform to the FDOT Specification on Directional Boring. A copy of this specification can be found in Appendix D of these Specifications.

### 1.02 DESIGN/PERFORMANCE REQUIREMENTS

A. Provide design engineering for the work as described in paragraph 1.2 and as described herein and on the contract drawings, including, but not limited to, the following elements:

1. Bore hole diameter and length,

2. Location of borehole entry and exit points,

3. Drilling procedures,

4. Pipeline pulling operations,

5. Method of drilling fluid disposal,

6. Area required for drilling operations and storage of pipe,

7. Drilling fluids management plan, and

8. Review of plan and profile drawings and proposed horizontal and vertical alignment of the pipeline, with written certification of agreement with them, or recommended departure from them.

B. The Contractor's submitted design shall be signed and sealed by a Professional Engineer whose specialty includes design of horizontal drilling operations. The cost of these engineering services will be included in the bid price.

C. The Contractor shall be responsible for conducting the job in accordance with all applicable federal, state and local permits, codes and statutes.

1.03 SUBMITTALS

A. Drawings:

1. Working drawings showing in detail the size and location of boring pits together with all sheeting and shoring to be used in supporting embankments and trench walls, and any other details of the proposed methods of installation required to allow adequate review by the engineer.

2. The Contractor shall prepare a drilling plan indicating equipment proposed for each location, pull-back forces anticipated and shall verify that the DR of the pipe specified is adequate to withstand the anticipated pull-back forces in addition to the earth, line and groundwater loads.

B. Shop Drawings:

1. Complete layout and details for fabrication and installation of pipeline; including design data and calculations.

2. Submittal shall include, but not be limited to, elements listed in the above Design/Performance Requirements paragraph.

C. Task Schedule:

1. Detailed schedule of tasks for each stage or operation involved in the work of this section. Include as a minimum the following major tasks:

a) Preparatory earthwork operations,

b) Drilling rig mobilization and set-up,

c) Pipe delivery and on-site pipe joining operations,

d) Pilot hole drilling and reaming operations,

e) Pipeline pulling operations,

f) Pipeline hydrostatic testing,

g) Drilling fluid disposal, and

h) Restoration and demobilization.

2. Task Schedule shall conform to contract schedule as outlined in the General Provisions.

3. On completion of pilot hole phase of each drill site, a complete set of "as-built" records shall be submitted in duplicate to the Engineer. These records shall include copies of the plan and profile drawing, as well as directional survey reports as recorded during the

drilling operation. Upon completion drawings shall be submitted to the engineer in ACAD 2000 file format.

4. Technical data of equipment to be utilized.

5. Prior to approval, submit the names of supervisory field personnel and historical information of directional boring experience.

6. Submit MSDS (Material Safety Data Sheets) information for the drilling slurry compounds.

D. Disposal Plan:

1. The plan shall describe the Contractor's plans for disposal of the drilling fluid and the names, addresses and telephone numbers of any and all subcontractors who will be performing any portion of the disposal activities.

2. At a minimum the plan shall include:

a) Disposal method,

b) Disposal hauler(s),

c) Disposal locations,

d) Estimated quantity to be disposed,

e) Type of vehicle hauling drilling fluids,

f) Signed statement that all hauling equipment (ie., vehicle, tanker, dump truck, trailer, etc.) meets all requirements of state agencies, and

g) Letter from proposed disposal site(s) accepting material.

E. Erosion Control Plan:

1. The erosion control plan shall be submitted prior to the preconstruction conference.

2. It shall be a written, detailed plan for the accomplishment of acceptable erosion control on the project.

3. The plan shall describe all necessary temporary measures to be implemented for preventing soil erosion from the construction site until permanent erosion control and finished surfaces are installed.

4. The plan shall comply with all state and local requirements.

F. Pipe Connection Procedures:

1. The Contractor shall submit pipe connection procedures to the Engineer prior to connecting any pipe.

2. For plastic (HDPE) pipe, the Contractor shall submit the pipe manufacturer's representative's written approval of his procedures.

1.04 PERMITS

A. N/A

1.05 QUALITY ASSURANCE

A. Crossings must conform to applicable requirements of all utility companies affected, State Highway Department, and environmental agencies.

B. Qualifications:

1. The Contractor shall be thoroughly experienced in the type construction contemplated herein.

C. References:

1. The Contractor must demonstrate expertise in trenchless methods by providing a list of five references for which similar work has been performed within the last two years.

2. Two of the references shall be from projects where the SAME SIZE OR LARGER pipe than the largest carrier pipe specified in the contract documents was successfully installed at a linear distance greater than or equal to the longest bore required by the contract documents.

3. The references shall include a name and telephone number where contact can be made to verify capability.

4. The subcontractor must provide documentation showing successful completion of the projects used for reference.

5. Conventional trenching experience will not be considered applicable.

D. Mandrel:

1. Upon completion of carrier pipe installation, Contractor shall pass a mandrel through the entire length of the bore in the presence of the Owner's representative to inspect for roughness and necking.

2. Mandrel shall not be more than 2-inches in diameter smaller than the ID of the carrier pipe installed.

3. Mandrel and towrope shall be constructed of materials that will not scar or harm the carrier pipe in any manner.

E. Pipe Manufacturer's Quality Control:

1. The pipe manufacturer shall have an ongoing Quality Control program for incoming and outgoing materials.

2. High-density polyethylene (HDPE) resins for manufacturing of pipe shall be checked for density, melt flow rate, and contamination.

3. These incoming resins shall be approved by NSF before being converted to pipe.

4. Pipe shall be checked for outside diameter, wall thickness, length, roundness, and surface

finish on the inside and outside and end cut.

F. Fittings Manufacturer's Quality Control:

1. The fitting manufacturer shall have an on-going quality control program for incoming and outgoing materials.

2. Molded fittings shall be inspected for voids and knit lines.

3. All fabricated fittings shall be inspected for joint quality and alignment.

4. All fabricated fitting welds shall be made using a Data Logger.

5. A record of the temperature, pressure and graph of the fusion cycle shall be maintained by the fitting manufacturer.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. The pipe and fitting manufacturer shall package products for shipment in a manner suitable for safe transport on commercial carriers.

B. When delivered, a receiving inspection shall be performed, and any shipping damage reported to the pipe and fittings manufacturer.

C. Pipe and fittings shall be handled, installed, and tested in accordance with manufacturer's recommendations and the requirements of this specification.

D. Deliver and store materials within limits of rights-of-way and/or property lines as shown on the drawings as directed by the owner.

E. The Contractor shall be responsible for securing all project materials and shall bear the cost of replacing any materials which may become misplaced or stolen.

1.07 JOB CONDITIONS

A. The Contractor shall be held fully responsible for protecting against surface subsidence, damage, or disturbance of adjacent property and facilities from his construction methods.

B. Each directional boring crew shall have a reasonable proportion of experienced men.

C. A superintendent and/or engineer experienced in directional boring methods and techniques, and who represents the boring contractor, shall be present at all times while work is proceeding. He shall also be responsible for the frequent checking of line and grade, if needed. Tolerances should be agreed to in the light gradient and easement requirements.

D. Contractor shall be held responsible for the coordination and scheduling of all construction work.

1.08 SAFETY

A. All drilling equipment must have a permanent, inherent alarm system capable of detecting an electrical current.

B. The ground system shall be equipped with an audible alarm to warn the operator when the drill head nears electrified cable.

C. All crews shall be provided with grounded safety mats, heavy gauge ground cables with connectors, and hot boots and gloves.

D. All supervisory personnel must be adequately trained and have direct supervisory experience in directional boring.

**PART 2 - PRODUCTS**

2.01 MATERIALS

A. Drilling fluid shall be a gel-forming colloidal fluid consisting of at least 10% of high-grade bentonite, which is totally inert and contains no environmental risk, or equal.

B. Carrier Pipe:

1. Pipe and fittings shall be high-density polyethylene manufactured from NSF approved PLEXCO P34CH compound, PE 3408, or equal.

2. Pipe shall meet AWWA C-906, PE Pressure Pipe and Fittings 4" – 53" for Distribution and be marked with the NSF-pw logo.

3. Hydrostatic design stress (HDS) shall be 800 psi at 73.4°F with a minimum pipe DR of 11 and operating pressure of 200 psi at 73.4°F.

4. Pipe and fittings shall be produced by the same manufacturer from identical materials meeting the requirements of this specification.

5. Molded fittings shall meet the requirements of ASTM D-3261 and this specification. At the point of fusion, the outside diameter and minimum wall thickness of fitting butt fusion outlets shall meet the outside diameter and minimum wall thickness specifications of ASTM F-714 for the same size of pipe.

6. Pipe shall be manufactured in accordance with ASTM F-714, ASTM D-3035, or the applicable dedicated service specification. Print line markings shall include a production code from which the location and date of manufacture can be identified. Upon request, the manufacturer shall provide an explanation of his production code.

C. Pipe Marking:

1. HDPE color coding shall be in accordance with the marking requirements specified herein.

D. Acceptable Pipe Manufacturer:

1. Performance Pipe, Driscoplex 4000, PE 3408, AWWA C-906, DIPS sizing, Richardson TX, (800) 527-0662; Supplier: ISCO Industries, Grand Bay, AL, 1-800-345-4726, or engineer approved equal.

E. Butt fusion Fittings:

1. HDPE fittings shall be PE 3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-99, and approved for AWWA use.

2. Butt fusion fittings shall have a manufacturing standard of ASTM D3261.

3. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless

otherwise specified in the plans.

4. Fabricated fittings are to be manufactured using Data Loggers.

5. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the Quality Control records.

6. All fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the working pressure rating of the fitting.

F. Transition Fittings:

1. Terminate all HDPE pipe with fusion welded flanges (125 lb bolt pattern). See paragraph above for alternate fusion procedures.

2.02 EQUIPMENT

A. Directional Drilling Equipment:

1. General:

a. The directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pull back the pipe, a drilling fluid mixing, delivery and recovery system of sufficient capacity to successfully complete the installation, a drilling fluid recycling system to remove solids from the drilling fluid so that the fluid can be reused (if required), a magnetic guidance system or walk over system to accurately guide boring operations, a vacuum truck of sufficient capacity to handle the drilling fluid volume, trained and competent personnel to operate the system.

b. All equipment shall be in good, safe condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of this project.

2. Drilling Rig:

a. The directional drilling machine shall consist of a hydraulically powered system to rotate and push hollow drilling pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head.

b. The machine shall be anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the installation.

c. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations.

d. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pullback pressure during pullback operations.

e. There shall be a system to detect electrical current from the drill string and an audible alarm which automatically sounds when an electrical current is detected.

3. Drill Head:

a. The drill head shall be steerable by changing its rotation and shall provide

necessary cutting surfaces and drilling fluid jets.

B. Guidance System:

1. General:

a. An electronic walkover tracking system or a Magnetic Guidance System (MGS) probe or proven gyroscopic probe and interface shall be used to provide a continuous and accurate determination of the location of the drill head during the drilling operation.

b. The guidance shall be capable of tracking at all depths up to 50 feet and in any soil condition, including hard rock.

c. It shall enable the driller to guide the drill head by providing immediate information on the tool face, azimuth (horizontal direction), and inclination (vertical direction).

d. The guidance system shall be accurate and calibrated to manufacturer's specifications of the vertical depth of the borehole at sensing position at depths up to fifty feet and accurate to 2-feet horizontally.

2. Components:

a. The Contractor shall supply all components and materials to install, operate, and maintain the guidance system.

3. The guidance System shall be of a proven type, and shall be set up and operated by personnel trained and experienced with the system.

4. The operator shall be aware of any geo-magnetic anomalies and shall consider such influences in the operation of the guidance system.

2.03 JOINING METHODS

A. Butt fusion joining:

1. Plain end pipe and fittings shall be made using butt fusion.

2. The butt fusion procedures shall be in accordance with the manufacturer or the PPI.

3. The fusion equipment operator shall receive training using the recommended procedure.

4. The Contractor shall be responsible to verify that the fusion equipment is in good operating condition and that the operator has been trained within the past twelve months.

5. The fusion equipment shall be equipped with a Data Logger. Records of the welds (heater temperature, fusion pressure, and a graph of the fusion cycle) shall be maintained for 5 years.

6. Fusion beads shall not be removed.

B. Mechanical Joining:

1. Polyethylene pipe and fittings may be joined together using flanges or mechanical joint

adapters.

2. These fittings shall be made from PE 3048 HDPE, with a Cell Classification of 345464C as determined by ASTM D3350-99.

3. Flanged and MJ adapters shall have a manufacturing standard of ASTM D3261.

4. They shall have a pressure rating equal to the pipe unless otherwise specified on the plans.

C. Electrofusion couplings:

1. Polyethylene pipe and fittings may be joined using approved electrofusion couplings.

2. Fittings shall be PE 3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-99.

3. Electrofusion fittings shall have a manufacturing standard of ASTM F1055.

4. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans.

5. All electrofusion fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the working pressure rating of the fitting.

**PART 3 - EXECUTION**

3.01 EXECUTION

A. The Utility bore depth will equal or exceed 10 times the bore size. The Contractor shall be responsible for setting all grade stakes, lines, and levels.

B. Coordinate the locations of underground utilities with appropriate companies. Advise Engineer immediately if conflict exists.

C. Contractor shall operate and maintain all equipment as required to keep the work free from excessive spoil and environmental risks.

D. N/A

E. The Contractor shall perform the necessary general earthwork operations as required for the directional drilling and pipe pulling operations.

F. The Contractor shall be responsible for restoring all areas impacted by contractors work effort to pre-work conditions. The Contractor shall be responsible for constructing all means of temporary access to the designated work sites and shall be liable for all damages caused as a result of the work.

3.02 INSTALLATION

A. Installation shall be in a trenchless manner producing continuous bores. The entry point shall be where shown on the plan submitted as required in 1.2 above. The exit point for the drilled hole shall be within 10 feet laterally and within 20 feet longitudinally of where shown on the plan submitted as required in 1.2 above. No exception to this requirement will be allowed.

B. The tunneling system shall be remotely steerable and permit electronic monitoring of tunnel depth

and location.

C. Tunneling must be performed by a fluid-cutting process (high pressure-low volume) utilizing a liquid clay, i.e., bentonite. The clay lining will maintain tunnel stability and provide lubrication in order to reduce frictional drag while the pipe is being installed. In addition, the clay fluid must be totally inert and contain no environmental risk.

D. The Contractor must also have a mobile vacuum spoils recovery vehicle on site to remove the drilling spoils from the access pits. The spoils must then be transported from the job site and be properly disposed of. Under no circumstances will the drilling spoils be permitted to be disposed of into sanitary, storm, or other public or private drainage systems.

E. Mechanical, pneumatic, or water-jetting methods will be considered unacceptable due to the possibility of surface subsidence.

F. After an initial bore has been completed, a reamer will be installed at the termination pit and the pipe will be pulled back to the starting pit. The reamer must also be capable of discharging liquid clay to facilitate the installation of the pipe into a stabilized and lubricated tunnel.

G. The Contractor shall provide all material, equipment, and facilities required for directional drilling. Proper alignment and elevation of the borehole shall be consistently maintained throughout the directional drilling operation. The method used to complete the directional drill shall conform to the requirements of all applicable permits.

H. The entire drill path shall be accurately surveyed with entry and exit stakes placed in the appropriate locations within the areas indicated on drawings. If Contractor is using a magnetic guidance system, drill path will be surveyed for any surface geo-magnetic variations or anomalies.

I. Contractor shall place silt fence between all drilling operations and any drainage, well-fields, wetland, waterway or other area designated for such protection necessary by documents, state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or drilling fluid spills shall be put in place, including berms, liners, turbidity curtains and other measures. Fuel may not be stored in bulk containers within 200 feet of any water body or wetland.

J. Readings shall be recorded after advancement of each successive drill pipe, (no more than 15') and the readings plotted on a scaled drawing of 1" = 5', both vertical and horizontal. Access to all recorded readings and plan and profile information shall be made available to the Engineer, or his representative, at all times. At no time shall the deflection radius of the drill pipe exceed the deflection limits of the carrier pipe as specified herein.

K. A complete list of all drilling fluid additives and mixtures to be used in the directional operation will be submitted to the Engineer, along with their respective Material Safety Data Sheets. All drilling fluids and loose cuttings shall be contained in pits or holding tanks for recycling or disposal, no fluids shall be allowed to enter any unapproved areas or natural waterways. Upon completion of the directional drill project, the drilling mud and cuttings shall be disposed of by the Contractor at an approved dumpsite.

L. The pilot hole shall be drilled on bore path with no deviations greater than 5% of depth over a length of 100-feet. In the event that pilot does deviate from the bore path more than 5-feet of depth in 100-feet, Contractor will notify Engineer and Engineer may require Contractor to pullback and re-drill from the location along bore path before the deviation. In the event that a drilling fluid fractures, inadvertent returns or returns loss occurs during pilot hole drilling operations, Contractor shall cease drilling, wait at least 30 minutes, inject a quantity of drilling fluid with a viscosity exceeding 120 seconds as measured by a March funnel and wait another 30 minutes. If mud fracture or returns loss

continues, Contractor will discuss additional options with the Engineer and work will then proceed accordingly.

M. Flange/MJ Adapter Installation: Flanges/MJ Adapters shall be attached to pipe and fittings using butt fusion. The flanges/MJ adapters shall be aligned and centered relative to the pipe. Flanges/MJ adapters should be square with the valve or other flange before tightening of bolts. Bolts should not be used to draw flanges into alignment. Bolt threads shall be lubricated, and flat washers shall be used under flange nuts. Bolts shall be tightened using a "star tightening pattern". See manufactures recommendations. Twenty-four hours after first tightening the flange bolts, they must be re-tightened using the same "star tightening patter" used above. The final tightening torque shall be as indicated by the manufacturer.

N. On each day butt fusions are to be made, the first fusion of the day shall be a trial fusion. The trial fusion shall be allowed to cool completely, then fusion test straps shall be cut out. The test strap shall be 12" or 30 times the wall thickness in length (minimum) and 1" or 1.5 times the wall thickness in width (minimum). Bend the test strap until the ends of the strap touch. If the fusion fails at the joint, a new trial fusion shall be made, cooled completely and tested. Butt fusion of pipe to be installed shall not commence until a trial fusion has passed the bent strap test.

O. Socket and saddle fusions shall be tested by a bent strap test as described by the pipe manufacturer. The pipe manufacturer shall provide visual guidelines for inspecting the butt, saddle and socket fusions joints.

P. The Contractor shall be liable for retrieving or sealing any pipe that becomes lodged in the drill hole.

3.03 PIPE PULLING OPERATIONS

A. The full length of the pipe to be installed shall be laid out, welded and tested in one complete unit before being pulled back through the drilled hole. Once started, pipeline pullback shall be continuous unless approved otherwise in writing by the Owner or Owner's designated representative.

B. The pulling head shall be designed by the Contractor to withstand the continuous tensile pull stresses with intermittent sudden occasional surges. The Contractor shall be responsible for determining the pulling loads.

C. The pipe shall be continuously lubricated with a bentonite slurry and the assembled pipeline shall be laid on rollers, or other apparatus, to facilitate pullback and prevent damage to pipe.

D. The Contractor shall continue pull back until 10 linear feet (minimum) of pipe is above ground for the purpose of pipe inspection.

E. A blind flange shall be bolted to the fusion welded flange and the pipe shall be marked and buried with a minimum cover of 36-inches. Connections, which will be made under another contract, will require the removal of the blind flange and a flanged ductile iron adapter shall be bolted to the fusion welded flange suitable for the transitional material. Provide restrained joints or Megalug joint restraint as required.

3.04TESTING

A. In addition to the water system testing requirements specified for the entire system, the Contractor shall conduct a low pressure air test of the HDPE reclaimed water and sewer force main above ground prior to pullback as follows:

1. Secure and brace ends of pipe to be tested.

2. Provide calibrated low range air pressure gauge on high end of pipe.

3. Fill pipe to maximum pressure of 20.0 psig. Add air as necessary to compensate for internal/external pipe temperature and initial pipe expansion. Check all pipe joints and test fittings with mild soap solution. Repair or replace all leaking joints, pipe and/or fittings.

4. Once air pressure has stabilized, pipe should hold constant air pressure for two hours. If pipe does not hold pressure, check all joints and test fittings with soap solution.

5. Repair or replace sources of leakage and completely retest entire section.

B. In addition to the water system testing requirements specified for the entire system, the Contractor shall conduct a hydrostatic test of the HDPE reclaimed water and sewer force main in-ground after pullback as follows:

1. Flush the HDPE main with potable water to remove any sediment, solids and/or foreign material prior to any in place testing. Then, fill the pipe with potable water and after all free air is removed from the test section, raise the pressure at a steady rate to the required pressure. The pressure in the section shall be measured with calibrated pressure gauges at each end of the pipe section.

2. Test pressure shall be 150 psi. The initial pressure test shall be applied and allowed to stand without makeup water for a sufficient time to allow for diametric expansion or pipe stretching to stabilize. This usually occurs within 2-3 hours. After this equilibrium period, the test section can be returned to 150 psi operating pressure, the pump turned off, and a final test pressure held for three hours.

3. Immediately following the pressure test, the results shall be furnished to the Engineer or Inspector. Leaking pipes that cannot be repaired to meet pressure test must be removed, filled with concrete, or otherwise placed out of service.

## 3.05 DAMAGED OR IMPROPERLY INSTALLED PIPE

A. If the pipe is damaged before installation, or does not meet the specifications, it shall be replaced at no expense to the Owner. If the pipe is damaged during installation by the Contractor's operations, placed at the improper grade or line, or cannot be advanced because of an unseen obstruction or any other reason, it shall, at the discretion of the Engineer, be retrieved or abandoned in place and the void filled with concrete by pressure grouting as soon as possible. If it becomes necessary to drill another hole, an alternate installation shall be made as directed by the Engineer.

B. The Contractor shall re-drill the hole and furnish all additional labor and materials required to complete the job as indicated on the plans and specifications at no additional cost to the Owner. The cost for retrieval or abandonment of pipe shall be at the expense of the Contractor. No additional payment shall be made for pipe which is retrieved, abandoned, or damaged beyond use, including dewatering, excavation, drilling, backfilling, etc.

C. Sections of pipe having been discovered with cuts or gouges in excess of 10% of the pipe wall thickness shall be cut out and removed. The undamaged portions of the pipe shall be rejoined using one of the joining methods allowed in the Section.

END OF SECTION

# SECTION 33 11 10
# WATER DISTRIBUTION SYSTEM

## 1. GENERAL

### 1.1 DESCRIPTION OF WORK
A. Extent of work is indicated on drawings and includes but is not limited to:
   1) Water mains.
   2) Appurtenances.
   3) Service laterals.

### 1.2 RELATED WORK
A. Section 30 00 00 - General Site Work Requirements
B. Section 31 23 16.13 - Earthwork for Utilities
C. Section 32 05 23 - Concrete for Site Work

### 1.3 SUBMITTALS
. comply with requirements of Section 30 00 00.

### 1.4 QUALITY ASSURANCE
. comply with requirements of Section 30 00 00.

## 2. PRODUCTS

### 2.1 GENERAL
A. Use materials in accordance with material standard and applicable laws, ordinances and codes.
B. Materials to be new, unused and correctly designed and of standard first grade quality intended for use.
C. Materials to be certified in accordance with ANSI/NSF 61.
D. Do not use materials or equipment which are inferior or of a lower grade than indicated, specified or required.

### 2.2 WATER MAINS
A. General: Type to be as shown on drawings or approved.
B. Marking: Pipe and tubing to be marked as prescribed in referenced AWWA and ASTM specifications.

### 2.3 DUCTILE IRON PIPE (DIP)
A. Pipe: Ductile iron pipe in accordance with AWWA C-150 and C-151, in nominal 18 or 20 foot laying lengths.
   1) Except as noted hereafter or shown otherwise on the drawings, use minimum pressure class 150 pipe.
      (a) For systems to be dedicated to a local municipality, verify and use pressure class as required by entity.
      (b) For private systems which provide fire flow to a building fire sprinkler system use minimum pressure class 200 pipe.
B. Joints: Joints may be push-on, mechanical or flanged type as shown on the drawings. Above ground piping to be flanged joint. Joint accessories to be furnished with pipe.
   1) Push-on type joints to be bell & spigot gasketed joints in accordance with AWWA C-111.
   2) Mechanical joints to be a bolted joint of the stuffing-box type in accordance with AWWA C-111.
   3) Flanged joints to be in accordance with AWWA C-110.

### 2.4 POLYVINYL CHLORIDE PIPE (PVC) - SMALLER THAN 4 INCHES
A. Pipe: SDR 21 pipe with a minimum pressure rating of 200 psi as manufactured in accordance with ASTM D-2241.
   1) Pipe color to be blue for potable water and purple for reclaimed water.
B. Joints: “Push-on” joints in accordance with ASTM D-3139.
   1) Glued joint pipe will not be allowed.
C. Gaskets: Use elastomeric gaskets in accordance with ASTM F-477.

## 2.5 POLYVINYL CHLORIDE PIPE -4 INCHES THROUGH 12 INCHES

A. Pipe: Use pipe manufactured in accordance with AWWA C-900, latest edition.
   1) Except as noted hereafter or shown otherwise on the drawings, use DR 18, pressure class 235 pipe.
      (a) For systems to be dedicated to a local municipality, verify and use pressure class as required by entity.
   2) Pipe color to be blue for potable water and purple for reclaimed water.
B. Joints: Joints may be push-on or mechanical type as shown on the drawings. Joint accessories to be furnished with the fitting.
   1) Push-on type joints to be bell & spigot gasketed joints in accordance with ASTM D-3139.
   2) Mechanical joints to be a bolted joint of the stuffing-box type in accordance with AWWA C-111.
C. Gaskets: Use gaskets in accordance with ASTM F-477.

## 2.6 POLYVINYL CHLORIDE (PVC) PIPE -14 INCHES THROUGH 48 INCHES

A. Pipe: Use pipe manufactured in accordance with AWWA C-905, latest edition.
   1) Except as noted hereafter or shown otherwise on the drawings, use DR 21, pressure class 200 pipe.
      (a) For systems to be dedicated to a local municipality, verify and use pressure class as required by entity.
   2) Pipe color to be blue for potable water and purple for reclaimed water.
B. Joints: Joints may be push-on or mechanical type as shown on the drawings. Joint accessories to be furnished with the fitting.
   1) Push-on type joints to be bell & spigot gasketed joints in accordance with ASTM D-3139.
   2) Mechanical joints to be a bolted joint of the stuffing-box type in accordance with AWWA C-111.
C. Gaskets: Use gaskets in accordance with ASTM F-477.

## 2.7 MOLECULARLY ORIENTED POLYVINYL CHLORIDE (PVCO) PIPE -6 INCHES THROUGH 12 INCHES

A. Pipe: Use pipe manufactured in accordance with AWWA C-909, latest edition.
   1) Except as noted hereafter or shown otherwise on the drawings use minimum pressure class 200 pipe.
      (a) For systems to be dedicated to a local municipality, verify and use pressure class as required by entity.
   2) Pipe color to be blue for potable water and purple for reclaimed water.
B. Joints: Joints may be push-on or mechanical type as shown on the drawings. Joint accessories to be furnished with the fitting.
   1) Push-on type joints to be bell & spigot gasketed joints in accordance with ASTM D-3139.
   2) Mechanical joints to be a bolted joint of the stuffing-box type in accordance with AWWA C-111.
C. Gaskets: Use gaskets in accordance with ASTM F-477.

## 2.8 POLYETHYLENE (PE) TUBING –SMALLER THAN 4 INCHES

A. Tubing: Use pipe manufactured in accordance with AWWA C-901, latest edition.
   1) Except as noted hereafter or shown otherwise on the drawings, use minimum pressure class 200 pipe.
      (a) For systems to be dedicated to a local municipality, verify and use pressure class as required by entity.
   2) Pipe color to be co-extruded blue striped for potable water and purple striped for reclaimed water.
B. Joints: Tubing to be continuous and joints will not be allowed without approval of Engineer.

## 2.9 POLYETHYLENE (PE) 4 INCHES THROUGH 63 INCHES

A. Pipe: Use pipe manufactured in accordance with AWWA C-906, latest edition.
   1) Except as noted hereafter or shown otherwise on the drawings, use minimum pressure class 160 pipe.
      (a) For systems to be dedicated to a local municipality, verify and use pressure class as required by entity.
      (b) For private systems which provide fire flow to a building fire sprinkler system, use minimum pressure class 200 pipe.
   2) Pipe color to be co-extruded blue striped for potable water and purple striped for reclaimed water.

B. Joints: Joints may be fused, flanged or mechanical type or as shown on the drawings. Joint accessories to be furnished with the fitting.
   1) Fused joints to be in accordance with manufacturer's recommendations.
   2) Flanged joints to be in accordance with AWWA C-207.
   3) Mechanical joints to be a bolted joint of the stuffing-box type in accordance with AWWA C-111.
C. Gaskets: Use gaskets in accordance with ASTM F-477.

**2.10 STEEL PIPE**
A. Steel pipe to be schedule 40 galvanized steel in accordance with ASTM A120.
B. Joints to be threaded.

**2.11 FITTINGS 3 INCHES AND LARGER**
A. General: Ductile iron fittings in accordance with AWWA C-110/A21.10 or C-153/A21.53 with a minimum pressure rating of 350 psi.
B. Coating: Use cement mortar lined and coated fittings in accordance with AWWA C-104.
C. Anchoring Devices: Ductile iron devices in accordance with ANSI/AWWA C-110, and/or C-111.
   1) Use sufficient number of set screws to restrain thrust at rated pressure without need for additional restraint.
D. Retainer Glands: Use Clow F-1058, American Cast Iron Pipe Co. M.J. Retainer Glands, EBAA Series 1200, NAPPCO Series 460, and Columbus Standard M.J. Retainer Glands, EBAA iron wedge action megalug, or an approved equal.
E. Push-on joint restraints to be similar to EBAA iron, series 800, or approved equal.
F. Coatings: Coatings to be as follows:
   1) Flange adapters to be provided with a painted "shop coat".
   2) Retainer glands to be provided with a bituminous coat.
   3) Push-on restraints to be provided with a bituminous coat.

**2.12 FITTINGS SMALLER THAN 3 INCHES**
A. General: Comply with requirements of AWWA C-800.
   1) Use stainless steel inserts at all fittings in polyethylene tubing. Comply with requirements of AWWA C-901.

**2.13 PRECAST THRUST BLOCKS**
A. General: Precast concrete thrust blocks manufactured to provide minimum dimensions and construction shown on plans and subject to approval by Engineer.
B. Concrete: Refer to applicable Division-30 specifications.

**2.14 BACKFLOW PREVENTERS**
A. General: Backflow preventers in accordance with AWWA C-506.
   1) Type and make to be as acceptable to local municipality.
   2) Devices to be tested and certified in accordance with requirements of the local municipality.
B. Piping Leads:
   1) 0 inches to 3 inches: Galvanized steel in accordance with requirements contained herein.
   2) 3" and greater: Ductile iron in accordance with requirements contained herein.
C. Strainers: All backflow preventers to be supplied with a strainer.

**2.15 FIRE HYDRANTS**
A. General: Post type dry-barrel hydrants in accordance with AWWA C-502 and approved by fire department or utility.
   1) The local municipality approved hydrant models are American Darling B-84-B, Mueller Centurion, M&H A-129, and Clow Medallion.
B. Type: Traffic rated compression type capable of opening against line pressure.
   1) Main valve to remain closed should hydrant be broken off above ground.
C. Pressure Rating: Hydrant to be rated at 150 psi working pressure and 300 psi hydrostatic pressure.
D. Size: 5-1/4 inch main valve, one 4-1/2 inch pumper nozzle and two 2-1/2 inch hose nozzles.
E. Auxiliary Valve: Supply with an auxiliary gate valve in accordance with requirements contained herein.

## 2.16 GATE AND TAPPING VALVES

A. General: Resilient seated in accordance with AWWA C-509 and following supplemental requirements:
   1) Valves 12 inches and smaller to be bubble-tight at 200 psi water working pressure.
   2) Test pressure to be twice rated working pressure and at all times zero leakage will be maintained.
   3) Class B gray iron body, non-rising stem suitable for buried vertical mounting.
      (a) Non-rising stem in accordance with AWWA specifications with cast integral stem collar and furnished of bronze conforming to ASTM B132 Alloy A.
      (b) Stem nuts to be independent of wedge and of solid bronze conforming to ASTM B-62.
   4) Sealing mechanism to be either a replaceable internally reinforced, specially contoured, molded rubber disc seat ring attached to face of disc with self-locking stainless steel screws or a sealing surface permanently bonded with resilient material to meet ASTM D-429.
   5) Replaceable seat rings to be designed to prevent improper installation
   6) Stuffing boxes to be o-ring seal type with two rings located in stem.
   7) Low friction torque reduction thrust bearings to be located both above and below stem collar.
   8) Valves to open by turning a two inch square AWWA operating nut clockwise.
B. Joints: Joints to conform with requirements for pipe.
C. All valves to be furnished with operating nuts.
D. All tapping valves to be interchangeable with other makes of tapping sleeves.

## 2.17 TAPPING SLEEVES

A. General: Heavy gray cast iron, ductile cast iron or high strength steel and in two halves.
B. Joints: Tapping sleeves to seal to pipe by use of a confined o-ring gasket able to withstand a pressure test of 150 psi with no leakage in accordance with AWWA C-110.
   1) A 3/4 inch NPT test plug to be provided for pressure testing.
   2) Outlet branch flange suitable for attachment by all makes of tapping valves meeting AWWA standards.

## 2.18 TAPPING SADDLES

A. General: Heavy gray cast iron or ductile cast iron, high strength steel, or brass with attachment straps and hardware.
B. Straps: 2 straps of stainless steel, brass, or corrosion resistant alloy steel in accordance with AWWA C-111.
C. Bands: Stainless steel.
D. Joints: Tapping saddles to seal to pipe by use of a confined o-ring gasket able to withstand a pressure test of 150 psi with no leakage in accordance with AWWA C-110.

## 2.19 COATINGS

A. Ductile iron pipe and fittings: Interior cement-mortar lining and exterior coal tar epoxy coating.
   1) Cement-mortar linings in accordance with AWWA C-104.
   2) Coal tar epoxy coatings in accordance with ANSI A21.51
B. Steel fittings: Interior and exterior fusion epoxy coated.
C. Valves: Interior and exterior to be epoxy coated in accordance with AWWA C-550.

## 2.20 WATER SERVICES

A. Service Lines: PE or PVC as specified herein.
B. Fittings: All fittings to be manufactured of brass, cast and machined in accordance with AWWA C-800.
   1) Fittings to be as manufactured by Mueller Company, Hays Manufacturing Company, Ford Meter Box Company, James Jones Company or A.Y. McDonald Manufacturing Company, or approved equal.
C. Service Saddles:
   1) Service saddles for pipe less than three inches to be a single band which is hinged or split from saddle body and is anchored by bolting one or more bolts between band and saddle body.
   2) Service saddles for pipe greater than three inches to vary in bolt patterns and band numbers based on type of pipe to be tapped.
   3) Service saddles for 6 inch and 8 inch PVC C-900 pipe to be a double wide single flexible band, or two bands, sized exactly for 6 inch and 8 inch PVC C-900 pipe and is to be anchored by a minimum four bolt pattern on saddle body.

4) Service saddles for ANSI/AWWA C-150 ductile iron pipe to be at least a single band, two bolt pattern saddle anchoring, or hinged wide single strap with one bolt assembly.
5) All other service saddles for pipe greater than three inches to use a double-wide single flexible band, or two bands, with a minimum of a four bolt pattern anchoring.

D. Inserts: For PE pipe, stainless steel inserts to be used at connections with corporation stops, curb stops and meter valves.

## 3. EXECUTION

### 3.1 GENERAL:

A. Conform with requirements of referenced standard specifications and manufacturer's recommendations.
B. Comply with requirements of Section 31 23 16.13 for excavation, bedding, and backfill.
C. Place water mains and services a minimum of 30 inches below grade and 36 inches below pavement.
D. Place 10 gauge insulated copper wire 3" to 6" above centerline of all non-metallic pipe and mains. Wire to terminate at top of each valve box and be capable of extending 12" above top of box without valve operation interference. All splices to be made using watertight sealing method.
E. Fire mains, fire lines, and any dedicated lines connecting a fire suppression system with water main system to be constructed and tested by a Licensed Fire Sprinkler Contractor in accordance with Florida Statute 633.
F. Maintain a vertical clear separation of 18 inches between water main and sanitary sewer, sanitary force main or storm sewer crossings.
   1) Sanitary or storm to cross under water main whenever possible.
   2) Adjust water main to provide necessary clearance.
G. Where a vertical clear separation of 18 inches cannot be provided, construct both water main and sanitary sewer or sanitary force main of DIP with 20 foot laying length. For crossings of existing utility, construct new pipe of DIP.
   1) Maintain a minimum separation of 10 feet between any two joints.
   2) Joints to be equidistant from crossing.
   3) All water main joints within 20 feet of crossing to be mechanically restrained.
   4) A minimum vertical separation of 6 inches to be required.
H. Maintain a lateral separation of 10 feet between water main and sanitary or storm sewer.
   1) When 10 foot separation cannot be maintained, place water main in separate trench or on undisturbed earth shelf located on one side of sewer or force main at such an elevation that the aforementioned 18 inch vertical clear separation is provided.
   2) When 18 inch clear vertical separation and 10 foot horizontal separation cannot be maintained, construct water main and sewer of DIP with 20 foot laying length, place water main a minimum of 6 inches clear vertically above sewer and stagger joints to provide maximum distance between water and sewer joints.
I. Verify location and elevation of points of connection prior to commencing work.

### 3.2 HANDLING

A. General: Handle pipe and appurtenances with care to avoid damage.
   1) Lift by hoists or slide or roll on skidways in such a manner as to avoid shock.
   2) Do not drop.
   3) Do not allow pipe on skidways to roll against pipe already on ground.
   4) Damaged materials will not be installed.
B. Avoid damage to coating and lining.
   1) Repair damage prior to installation.
C. Pipe to be distributed on site of work parallel with and opposite or near place it is to be laid in trench and with bell ends facing directions in which installation will proceed unless otherwise directed.

### 3.3 INSTALLATION OF PIPE

A. Thoroughly clean pipe interior of foreign material before lowering into trench and keep clean during laying operations by means of plugs or other approved methods.
B. Properly position joint gaskets before pipe is lowered into trench.
C. Join pipe in accordance with manufacturer's requirements.

D. Install watertight plugs in open ends of pipe at all times when pipe laying is not in progress.
E. Do not allow trench water to enter pipe.
F. Perform cutting of pipe for inserting valves, fittings or closure pieces in a neat and workmanlike manner without damage to pipe.
   1) Bevel ends of cut pipe to prevent edge from damaging gasket upon insertion.
G. Whenever necessary to deflect pipe, either in vertical or horizontal plane, to avoid obstructions, maximum allowable deflection to be in accordance with manufacturer's recommendations.
H. Do not lay pipe in water or when trench conditions or weather is unsuitable.
I. Any pipe which is damaged or found to be defective after laying to be taken up and re-laid or replaced.
J. Backhoe buckets or excavation equipment are not to be applied directly to pipe.
K. If a joint is defective, it shall be cut out and entirely replaced or, if permission is given by Engineer, it may be repaired by a suitable clamp.

**3.4 INSTALLATION OF FITTINGS**

A. Fittings: Set and join to pipe in a manner specified previously for joint assembly. When conditions warrant, fittings should be provided with special support trussing and blocking.

**3.5 INSTALLATION OF VALVES**

A. General: Install in accordance with manufacturer's recommendations and referenced standard specifications.
B. Valves to be set and joined to new pipe in manner heretofore specified for cleaning, laying and joining pipe.
C. Valve Boxes: Cast iron valve boxes to be firmly supported and maintained centered and plumb over operating nut of valve with box cover flush with surface of finished pavement or at such other level as may directed.
   1) Boxes set in non-paved areas to have 24 inch square concrete pads centered and poured around top section of valve box.
   2) Valve covers to be painted safety blue as prescribed by American Public Works Association (APWA) uniform color code for utility systems and cast with word "Water" or letter W.
   3) Install valve and box to allow complete opening and closing by insertion of a valve key through valve box.
D. Blow-Offs: Blow-offs shall not be connected to any sewer or submerged in any stream or be installed in any other manner that will permit back-siphonage of contaminated water into distribution system.

**3.6 INSTALLATION OF TAPS**

A. General: Use material, equipment and procedures in accordance with AWWA Standards.
B. Sterilize material and equipment in accordance with AWWA Standards.
C. Pressure test sleeve and valve prior to performing tap to insure a watertight joint.

**3.7 ANCHORAGE OF BENDS, TEES AND PLUGS**

A. General: Prevent separation of joints at bends, tees and ends by providing adequate thrust restraint using thrust blocking or mechanical devices as selected by Contractor.
B. Concrete for Thrust Blocking: Comply with requirements of applicable Division-30 or Division-03 specifications.
C. Thrust Blocking: Place between undisturbed earth and fitting to be anchored with area of bearing on pipe and ground as shown on drawings.
   1) Place concrete so that pipe and fitting joints will be accessible for repair.
D. Precast thrust blocks may be used in lieu of poured-in-place blocks on eight inch and smaller water mains.
   1) Placement will be in accordance with standard procedures for restraining thrust.
   2) Earth behind blocks will be either undisturbed or compacted to a minimum of 95% AASHTO T-180.
E. Mechanical Devices: Install in accordance with manufacturer's recommendations.

**3.8 TESTING AND INSPECTION REQUIREMENTS**

A. General: Coordinate all testing and inspections and notify Engineer and agency inspectors 48 hours in advance. Tests to be observed by Engineer.

B. Fusion Joint Quality: Contractor to supervise and verify fusion procedures as well as field set-up and operation of fusion equipment by on-site fusion operator. At the option of the Engineer, Field verify fusion quality by making and testing a trial fusion. Allow trial fusion to completely cool, then cut out and bend test straps in accordance with ASTM D 2657. If trial fusion bent strap test fails at the joint, then field fusions represented by the trial fusion shall be rejected. Contractor, at his expense, to make all necessary corrections to equipment, set-up, operation and fusion procedure, and shall re-make the rejected fusions.

## 3.9 HYDROSTATIC TEST

A. Hydrostatic Test: Perform hydrostatic pressure test for a minimum of two hours on all domestic/combined services, mains and fittings at a minimum pressure of 150 psi in accordance with AWWA C-605 for PVC and PVCO, and AWWA C-600 for all other pipe. For dedicated fire mains and fittings, perform test for a minimum of two hours at a minimum pressure of 200 psi in accordance with NFPA 24-8-9.
   1) Perform test at any convenient time upon backfill and after piping has been cleaned and flushed.
   2) Prior to test, allow adequate curing time for reaction blocking.
   3) At request of Engineer, furnish certified test data for pressure gauges and recorders.
   4) When requested, provide chart recorders.
   5) Test in sections not exceeding one-half mile or as recommended by references.
   6) Expel all air prior to test by making any necessary taps and afterward install tapered brass plugs.

B. Pump test section to a pressure greater than minimum test pressure.
   1) Do not exceed minimum test pressure by more than 25 psi.
   2) If required, provide pressure relief valves pre-set to test pressure plus 25 psi.
   3) For PE pipe, gradually increase pressure to 10 psi above test pressure and maintain for 3 hours to allow for initial expansion, then reduce pressure to test pressure prior to commencement of leakage test. Make-up water during initial expansion phase is not considered in leakage test.

C. Maintain test pressure in excess of minimum by pumping water into test section.
   1) Do not allow pressure fluctuations greater than 5 psi.
   2) Failure to maintain pressure above minimum pressure will void test.

D. At end of two hour test period, adjust pressure to highest pressure obtained during duration of test period by pumping water into test section and then measure total amount of water used during test.

E. Test leakage is the volume of water required to maintain test pressure in excess of minimum pressure during duration of test period plus volume required at conclusion of test to bring line pressure back up to highest pressure obtained during duration of test period.

F. Allowable leakage test for services, water mains and fittings at 150 psi not to exceed that shown in following table. Allowable leakage for other pressures to be in accordance with test standards above.
   1) An additional leakage of 0.0078 gallons per hour per inch of diameter is allowed when testing against closed valves.

| Two Hour Hydrostatic Test Allowable Leakage | | | |
|---|---|---|---|
| Nominal Pipe Dia. (In.) | Gallons/1000 Ft. of Pipe | Nominal Pipe Dia. (In.) | Gallons/1000 Ft. of Pipe |
| 0.75 | 0.12 | 10 | 1.66 |
| 1 | 0.16 | 12 | 1.99 |
| 1.5 | 0.25 | 14 | 2.32 |
| 2 | 0.33 | 16 | 2.65 |
| 2.5 | 0.41 | 18 | 2.98 |
| 3 | 0.50 | 20 | 3.31 |
| 4 | 0.66 | 24 | 3.97 |
| 6 | 0.99 | 30 | 4.96 |
| 8 | 1.32 | 36 | 5.96 |

G. Allowable test leakage for fire mains and fitting to be in accordance with NFPA 24-8-9.

H. Leakage Correction:
   1) Mechanical joints: Tighten gland (do not exceed required torque).

2) Push-on joints: Cut out and entirely replace joint, or when allowed repair by a suitable clamp.
3) Remove and replace all cracked or defective pipes, fittings, valves or hydrants.
4) Repeat test upon correction.

l. Contractor is warned that pressure testing against existing "end-of-line" or blow-off valves is done at his own risk. Failure will not relieve Contractor of test requirements or result in additional compensation for extra work performed.

**3.10 DISINFECTION**

A. Disinfection: Thoroughly flush to remove all foreign material and sterilize in accordance with AWWA C-651.

B. Bacteriological Testing: After disinfecting and final flushing and before system is placed in service, perform testing by laboratory, state certified in accordance with Chapter 403, Florida Statutes.
1) Test two samples, taken one per day on consecutive days, for each half mile of main and for each branch.
2) If Engineer determines uncontrolled water has entered main, or excessive quantities of dirt or debris have entered main, obtain and test bacteriological samples at 200 feet intervals identified by location.
3) Obtain samples from water that has stood in main for at least 16 hours after final flushing.
4) Collect samples in sterile bottles treated with sodium thiosulfate as required by "Standard Methods for Examination of Water and Wastewater".
5) Do not use hose or fire hydrant in collection of samples. A corporation cock may be installed in main with a copper tube gooseneck assembly. After samples have been collected, gooseneck assembly may be removed.
6) Bacteriological testing must be performed concurrent to the as-built survey of the water system described in Section 30 00 00, item 3.9. If the as-built survey is delayed, bacteriological testing must be repeated at the time of the as-built survey for use in certification of the system. Bacteriological tests older than 60 days are not valid for use in system certification.

**3.11 PLACEMENT INTO SERVICE**

A. General: Except for single services, do not place system into service until a letter of clearance has been obtained from the Florida Department of Environmental Protection. Prior to this time, limit operation to disinfection, testing for leaks, and testing equipment operation.

B. Coordination: Coordinate construction, inspections, testing and as-built surveys for completion not less than 45 days prior to issuance of certificate of occupancy or placement into service.

## 4. MEASUREMENT AND PAYMENT

**4.1 GENERAL**

A. The contract unit price to be compensation in full for furnishing all materials, labor, equipment, tools and incidentals necessary for completion in every detail in accordance with plans and specifications.
1) There will be no separate payment for clean-up and restoration of property, or other items under this section unless specifically identified on the proposal, bid form, or contract.

**END OF SECTION 33 11 10**

# SECTION 33 31 00
# SEWER COLLECTION SYSTEM

## 1. GENERAL

### 1.1 DESCRIPTION OF WORK
A. Extent of work is indicated on drawings and includes but is not limited to:
   1) Sanitary sewer mains.
   2) Sewer laterals (services).
   1) Manholes, frames and covers.

### 1.2 RELATED WORK
A. Section 30 00 00 - General Site Work Requirements
B. Section 31 23 16.13 - Earthwork for Utilities
C. Section 32 05 23 - Concrete for Site Work

### 1.3 SUBMITTALS - comply with requirements of Section 30 00 00.

### 1.4 QUALITY ASSURANCE - comply with requirements of Section 30 00 00.

## 2. PRODUCTS

### 2.1 GENERAL
A. Use materials in accordance with material standard and applicable laws, ordinances and codes.
B. Materials to be new, unused and correctly designed and of standard first grade quality intended for use.
C. Do not use materials or equipment which are inferior, of a lower grade than indicated, specified, or required.

### 2.2 GRAVITY SEWER
A. General: Type shall be as shown on drawings.
B. Marking: Pipe and tubing to be marked as prescribed in referenced ASTM specifications.
C. Furnish ells, tees, reducing tees, wyes, couplings, crosses, transitions and end caps of same type and class of material as conduit, or of material having equal or superior physical and chemical properties as acceptable to Engineer.

### 2.3 POLYVINYL CHLORIDE PIPE (PVC)
A. Pipe: SDR 35 in accordance with ASTM D-3034 and D-1784. Pipe color shall be green.
B. Joints: Bell and spigot type conforming to ASTM D-3212 using factory installed, flexible elastomeric seals.
C. Elastomeric seals shall conform to ASTM F-477.
D. Coatings: Not required.
E. Cutting: PVC sewer pipe may be field cut using hand or power saws in accordance with manufacturer's recommendations. Raw spigot end thus formed shall be filed to remove gasket-damaging burrs and to form a standard bevel.
F. Fittings: PVC sewer pipe fittings shall comply with ASTM D-3034, ASTM D-3212 and have elastomeric seals conforming to ASTM F-477.

### 2.4 DUCTILE IRON PIPE
A. Pipe: Class 52 with a minimum tensile strength of 60,000 psi, a minimum yield strength of 42,000 psi, and a minimum elongation of 10% and in accordance with AWWA C-150/ANSI A 21.50.
B. Joints: Slip-on type with a single rubber gasket or mechanical joints in accordance with AWWA C-110/ANSI A 21.10.
C. Coatings: Interior and exterior bituminous coating in accordance with ANSI A-21.6, A-21.8 or A-21.51.

### 2.5 MANHOLES
A. General: Precast reinforced concrete sections in accordance with ANSI/ASTM C-478.
   1) Each manhole shall have a base section or tee section, barrel section and top, all as required.
B. Manhole Barrels: Constructed with preformed openings to meet indicated pipe alignment conditions and invert elevations.

1) Preformed opening not greater than 4 inches larger than outside diameter of pipe or pipe bell to be connected.
2) Distance between nearest edge of preformed openings and shoulder of barrel joint shall be 6 inches minimum.

C. Manhole Joints: Constructed with integral joints to prevent ground water infiltration.
1) Joints shall be tongue and groove with “ram-neck” or o-ring compression rubber gaskets in accordance with Federal Specification SS-S-210-A.

D. Manhole Connector: Use flexible pipe to manhole connector in connection of sewer pipe to pre-cast manhole.
1) Flexible connector shall be a Kor-N-Seal connector or equal and shall comply with ASTM C-443 and ASTM C-923 and consist of material designed to be resistant to ozone, weather elements, chemicals, including acids, alkalis, animal and vegetable fats, oils and petroleum products.

E. Invert Channel: Invert channels shall be constructed smooth and semicircular, conforming to inside of adjacent sewer section.
1) Mortared invert shall be made with a smooth curve using as large a radius as possible.
2) Changes in size and grade shall be made gradually and smoothly.
3) Benches shall be built up solidly with concrete or brick and mortar and shall be built whenever inside drop exceeds 24 inches.
4) All pipe entering manhole must be trimmed flush with walls.
5) All exposed sharp edges of pipe shall be wiped smooth with mortar.

F. Concrete Base: Precast or cast-in-place at Contractor’s option.
1) Use concrete which will attain a 28-day compressive strength of not less than 3000 psi.
2) Use reinforcing steel with a yield strength of not less than 60,000 psi in accordance with ASTM A-615.

G. Tops: Use flat concrete slab for manholes less than 6 feet in depth and an eccentric cone for all others.

H. Coatings: 2 coats of coal tar epoxy with a minimum total thickness of 16 mils interior and/or exterior as required by utility.

### 2.6 MASONRY MATERIALS

A. Brick: ANSI/ASTM C-32, Grade MS.

B. Masonry Mortar: ANSI/ASTM C-270, Type M.

C. For minor amounts of mortar, packaged materials complying with ANSI/ASTM C-387, Type M, will be acceptable.

### 2.7 METAL ACCESSORIES

A. Manhole Frames and Covers: Gray cast iron, ANSI/ASTM A-48, Class 30 B.
1) Furnish covers with cast-in legend “Sanitary” or in accordance with utility.

B. Manhole Steps: Gray cast iron, ANSI/ASTM A-48, Class 30 B, integrally cast into manhole sidewalls, unless otherwise indicated.

## 3. EXECUTION

### 3.1 GENERAL:

A. Conform with requirements of referenced standard specifications and manufacturer’s recommendations.

B. Comply with requirements of Section 31 23 16.13 for excavation, bedding, and backfill.

C. Place lines a minimum of 30 inches below grade and 36 inches below pavement.

D. Place 10 gauge insulated copper wire 3” to 6” above centerline of all non-metallic pipe. Wire to terminate at top of cleanouts.

E. Comply with requirements of Section 33 11 10 for separation with water mains.
1) Maintain a horizontal separation of 10 feet between water main and sanitary sewer.
2) When bottom of water main is 18 inches above top of sanitary sewer and located in a separate trench, a lesser horizontal separation may be used when specifically dimensioned on plans or if prior approval is obtained from Engineer.

F. Verify location and elevation of points of connection prior to commencing work. Perform work to avoid interruptions to service where possible. Required service interruptions shall be performed during off-peak hours.

### 3.2 CLOSING ABANDONED UTILITIES

A. Close open ends of abandoned underground utilities indicated to remain in place.

B. Provide sufficiently strong closures to withstand hydrostatic or earth pressure which may result after closure.
1) Close with plastic plugs, or other acceptable methods suitable for size and type material being closed.
2) Wood plugs are not acceptable.

3) Close concrete or masonry utilities with not less than eight inch thick brick masonry bulkheads.

## 3.3 HANDLING

A. General: Handle pipe and appurtenances with care to avoid damage.
   1) Lift by hoists or slide or roll on skidways in such a manner as to avoid shock.
   2) Do not drop.
   3) Do not allow pipe on skidways to roll against pipe already on ground.
   4) Damaged materials will not be installed.
B. Avoid damage to coating and lining.
   1) Repair damage prior to installation.
C. Pipe shall be distributed on site of work parallel with and opposite or near place it is to be laid in trench and with bell ends facing directions in which installation will proceed unless otherwise directed.

## 3.4 INSTALLATION OF PIPE

A. General: Comply with requirements of Section 31 23 16.13 for excavation, bedding and backfill.
B. Ductile Iron Pipe: Install in accordance with manufacturer's recommendations and DIP research association publication "A Guide for Installation of Ductile Iron Pipe".
C. Polyvinyl Chloride Pipe: Install in accordance with ASTM D-2321 and Uni-Bell standard UNI-B-5.
   1) Deflection shall be limited to 7.5% in accordance with ASTM D-3034.
D. All sewer lines shall be laid to lines, grades and elevations contained within plans such that as-built slopes shall not deviate more than 10 percent from slopes shown on construction documents nor more than 0.10 feet from inverts shown on construction plans, whichever is less.
   1) For runs less than 250 feet, increase slopes and adjust inverts as required to insure that as-built slopes shall not deviate more than 10 percent from minimum slope shown on plans.
   2) Deviations which result in slopes less than 10 percent of minimum slope requirement shall be removed and replaced at no cost to Owner and shall include cost of any and all work by others which may be disturbed by such removal and replacement
E. Clean interior of all foreign material before being lowering into trench and keep clean by means of plugs or other approved methods.
F. Do not lay pipe in water or when trench conditions or weather is unsuitable for such work.
G. Pipe laying shall proceed up grade with spigot ends pointing in direction of flow.
   1) Lubricate spigot ends of pipe with a lubricant specified by pipe manufacturer prior to joining.
   2) Apply sufficient pressure to pipe to properly seat socket in bell of pipe.
   3) Joint Adapters: Make joints between ductile iron pipe and other types of pipe with standard manufactured ductile iron adapters and fittings.
H. Whenever pipe laying is stopped for night or for any other cause, end of pipe shall be securely closed with a stopper to prevent entrance of water, mud or other obstructing matter, and shall be secured to prevent being dislodged by sliding or other movement of backfilling.
I. Minimize interruptions to existing utilities.
J. Any pipe which is damaged or found to be defective after laying shall be taken up and re-laid or replaced.
K. After each pipe is laid it shall be partly backfilled and made secure before next joint is laid.
L. Interior Inspection: Inspect pipe to determine whether line displacement or other damage has occurred.
M. Make inspections after lines between manholes, or manhole locations, have been installed and approximately two feet of backfill is in place and at completion of project.
N. If inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, correct such defects to satisfaction of Engineer.

## 3.5 LATERALS AND SERVICES

A. Install laterals from sewer main to ROW line, 2 feet beyond back of curb, or within 5 feet of building as shown on construction plans and mark end.
   1) Ends of laterals shall terminate at such depth as required to serve adjacent property except that maximum depth below ground surface at end of lateral shall be four feet.
   2) In sewers over eight feet in depth, or where directed, stacks shall be carried up from tee connections at an angle of 45 degrees with vertical, and end shall terminate at depth specified for laterals.
   3) Ends of stacks or laterals shall be closed with covers as specified for tee branches.
   4) Mark lateral end point as shown on drawings.
   5) Permanently scribe lateral crossing of concrete curbs, gutters or valley gutters where present.
   6) Materials for stacks and laterals shall be as shown on drawings or designated in proposal.

B. Wherever house laterals are intercepted by excavation for new sewer, connection shall be maintained temporarily to old sewer until particular section of new sewer is completed and tested. Then house lateral shall be broken and reconnected to new sewer through a tee which shall have been placed in sewer for that purpose.

**3.6 UNDERGROUND STRUCTURES**

A. Precast Concrete Manholes: Place as shown on drawings.
   1) In paved areas, set tops of frames and covers flush with finish surface.
   2) In unpaved areas, set tops three inches above finish surface, unless otherwise indicated.
B. Use epoxy-bonding compound where manhole steps are mortared into manhole walls.
C. Provide drop manholes as shown on plans.

**3.7 JOINING PIPE TO MANHOLES OR OTHER STRUCTURES**

A. Connect pipe to manhole or other structure using flexible connector such as Kor-n-seal connector or approved equal in accordance with ASTM C-443 and ASTM C-923.
B. Stubouts for future mains shall be constructed at locations and to elevations shown on plans.
   1) Stubouts shall be plugged with bricks and mortar per detail shown on plans.

**3.8 TESTING AND INSPECTION REQUIREMENTS -** comply with requirements of Section 30 00 00. Tests to be observed by Engineer.

## 4. OPERATION AND MAINTENANCE

**4.1 GENERAL:**

A. Maintain systems during construction to prevent depositions of sediments and debris into manholes and lines.
B. Inspect and remove any sediments and debris prior to placement into service.

**4.2 PLACEMENT INTO SERVICE**

A. General: Except for single services, do not place system into service until a letter of clearance has been obtained from the Florida Department of Environmental Protection. Prior to this time, limit operation to testing.
B. Coordination: Coordinate construction, inspections, testing and as-built surveys for completion not less than 45 days prior to issuance of certificate of occupancy or placement into service.

**4.3 POST-CONSTRUCTION RECOMMENDED OPERATION AND MAINTENANCE PROCEDURES**

A. General
   1) Operation and maintenance procedures shall be in accordance with “Operation and Maintenance of Wastewater Collection Systems”, California State University, Department of Civil Engineering, 1980.
   2) Operation and maintenance procedures shall be in accordance with “Wastewater Collection Systems Management Manual of Practice No. 7, Water Environment Federation.
   3) Systems shall be operated and maintained so as to provide uninterrupted service.
   4) Inspections to be performed by licensed service professional for private systems or appropriate maintenance entity for public systems.
B. Gravity Collection System
   1) Facility procedures should be implemented to prevent unauthorized disposal or connection from sources such as stormwater, chemicals, industrial wastes, flammables, or other products.
   2) Manholes should be inspected on a biannual basis for debris and blockages. Deficiencies should be corrected.
   3) Manholes should be inspected on an annual basis following a significant rainfall event for evidence of stormwater infiltration. Deficiencies should be corrected.
   4) The complete system should be inspected once every three years. Deficiencies should be corrected.

## 5. MEASUREMENT AND PAYMENT

**5.1 GENERAL**

A. The contract unit price shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals necessary for completion in every detail in accordance with plans and specifications.
   1) There will be no separate payment for clean up and restoration of property, or other items under this section unless specifically identified on the proposal, bid form, or contract.
B. Sewer Pipe:

1) When payment is on a lineal basis, contract unit price for various sizes, types and depths of pipe shall be compensation in full for one linear foot of pipe complete and in place.
2) When payment is on a lineal basis with depth of cut classifications, contract unit price shall be compensation in full for one linear foot of pipe within depth of cut classification complete and in place.
3) Length of pipe will be measured horizontally from center of structures and ends of pipes, except, mitered end sections will not be included in the length of concrete pipe. When depth of cut classifications are included in contract unit price, classification will be vertical distance from natural ground surface or subgrade of roadway, whichever is least, to pipe invert.
   (a) Depth of cut will be vertical distance from ground surface or subgrade, whichever is least, to pipe invert.

C. Manholes: When payment is on a per unit basis with depth of cut classifications, contract unit price shall be compensation in full for one structure of various size, type and depth complete with frames and covers, steps, inverts, connections and stub-outs in place.
   1) Depth of structure shall be vertical distance from top of structure to invert.

END OF SECTION 33 31 00

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# SECTION 33 40 00
# STORM SEWER COLLECTION SYSTEM

## 1. GENERAL

### 1.1 DESCRIPTION OF WORK

A. Extent of work is indicated on drawings and includes but is not limited to:
   1) Storm sewer piping.
   2) Manholes, frames and covers.
   3) Grate inlets, frames and gratings.
   4) Outfall structures.
   5) Junction boxes.
   6) Endwalls.
   7) Mitered end sections.
   8) Riprap.
   9) Skimmers.

### 1.2 RELATED WORK

A. Section 30 00 00 - General Site Work Requirements
B. Section 31 20 00 - Earthwork
C. Section 31 23 16.13 - Earthwork for Utilities
D. Section 32 05 23 - Concrete for Site work or Division-03 Section for Concrete

**1.3 SUBMITTALS -** comply with requirements of Section 30 00 00.

**1.4 QUALITY ASSURANCE -** comply with requirements of Section 30 00 00.

## 2. PRODUCTS

### 2.1 CONDUIT MATERIALS

A. Reinforced Concrete Pipe (RCP): ANSI/ASTM C76, Class Ill, Wall 'B', with bell and spigot joints using o-ring rubber gaskets and complying with ANSI/ASTM C 443,
B. Fiber Reinforced Concrete Pipe (FRCP): FDOT 449, Class Ill, with bell and spigot joints using o-ring rubber gaskets and complying with the hydrostatic requirements of ANSI/ASTM C 443,
C. Corrugated Polyethylene/Polypropylene Pipe (CPE or CPP):
   1) Smaller than 12": Double wall high density polyethylene pipe with corrugated exterior and smooth interior such as ADS N-12 WT IB or equal in accordance with AASHTO M252 Type S or ASTM F2648. Joints to be watertight in accordance with ASTM D3212. Fittings to be in accordance with ASTM F2306.
   2) 12" and greater: Double wall polypropylene pipe with corrugated exterior and smooth interior such as ADS N-12 HP or equal in accordance with ASTM F2736. Joints to be bell and spigot in accordance with ASTM F2736 and watertight in accordance with ASTM D3212. Fittings to be in accordance with ASTM F2736.
D. Polyvinyl Chloride Pipe (PVC): In accordance with ASTM D3034 and D1784 and meeting dimension requirements of standard dimension ratio (SDR) 35. Joints to be bell and spigot type conforming to ASTM D3212 using factory installed flexible elastomeric seals. Elastomeric seals to conform to ASTM F477. Color to be white.

### 2.2 CONCRETE STRUCTURES

A. Concrete Base: Precast or cast-in-place, at Contractor's option. Use concrete which will attain a 28-day compressive strength of not less than 3000 psi. Use reinforcing steel with a yield strength of 60,000 psi in accordance with ASTM A615.
B. Precast Concrete Structures: ANSI/ASTM C478, size and modifications as indicated with modified

tongue-and-groove compression gasket joints or bell and spigot joints using o-ring rubber gaskets and complying with ANSI/ASTM C443.

C. Cast-In-Place Concrete Structures: Use concrete with a minimum 28-day compressive strength of not less than 3000 psi. Use reinforcing steel with a yield strength of 60,000 psi in accordance with ASTM A615. Joints when necessary to be modified tongue-and-groove compression gasket joints complying with ANSI/ASTM C443.

### 2.3 MASONRY MATERIALS

A. Concrete Masonry Units: ANSI/ASTM C139.
B. Manhole Brick: ANSI/ASTM C32, Grade MS.
C. Sewer Brick: ANSI/ASTM C32, Grade SS.
D. Masonry Mortar: ANSI/ASTM C270, Type M.
E. For minor amounts of mortar, packaged materials complying with ANSI/ASTM C387, Type M, will be acceptable.

### 2.4 METAL ACCESSORIES

A. Manhole Frames and Covers: Gray cast iron in accordance with ANSI/ASTM A48, Class 30 B. Manhole frames and covers to be traffic rated.
B. Manhole Steps: Gray cast iron, ANSI/ASTM A48, Class 30 B, integrally cast into manhole sidewalls, unless otherwise indicated.
C. Inlet Grates and Frames: Gray cast iron in accordance with ANSI/ASTM A48, Class 30 B unless noted otherwise. Steel grates and frames to be galvanized steel in accordance with ASTM A123.
   1) Grates and frames to be traffic rated, except grates in retention and detention areas may be non-traffic rated.

### 2.5 RIP-RAP

A. General: Riprap material to be crushed quarry stone, crushed concrete, or as specified on drawings.
B. Gradation: Graded mixture with individual pieces weighing, in general from 20 to 300 pounds with not more than 25% weighing less than 50 pounds, and at least 50% weighing 100 pounds or more, or as shown on the drawings.
C. Stone to be sound and durable quarry stone material with a minimum specific gravity of 1.90.
D. Material to be free of cracks, soft seams, debris, rebar, structural defects and to be roughly angular and reasonably free from thin, flat or elongated pieces.
E. Geotextile: Fabric to be Mirafi 500-X or approved equal.

## 3. EXECUTION

### 3.1 EXCAVATION, BEDDING AND BACKFILL - comply with requirements of Section 31 23 16.13.

### 3.2 INSTALLATION OF CONDUIT

A. General: Install conduit in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.
   1) Inspect for defects before installation. Mark defective materials and promptly remove from site.
   2) Lay beginning at low point of system, true to grade and alignment indicated with unbroken continuity of invert.
   3) Place bell ends or groove end of pipe facing upstream.
   4) Install gaskets in accordance with manufacturer's recommendations.
B. Concrete Pipe: Install in accordance with applicable provisions of American Concrete Pipe Association "Concrete Pipe Field Manual", unless otherwise indicated.
   1) Place circular concrete pipe with elliptical reinforcing so that reference lines indicating top of pipe are not more than 5 degrees from vertical plane through longitudinal axis of pipe.
C. CPE Pipe: Install in accordance with manufacturer's recommendations.
D. PVC Pipe: Install in accordance with manufacturer's recommendations.
E. Cover requirements: Clear cover between top of pipe and bottom of base, pavement, or grade to not be less than requirements contained in FDOT Index 205.

F. Cleaning Conduit: Clear interior of conduit of dirt and other superfluous material as work progresses.
   1) Maintain swab or drag line and pull past each joint upon completion.
   2) Use brushes and brooms in large, accessible conduits.
   3) Place plugs in ends of uncompleted conduit at end of day or whenever work stops.
   4) Flush lines between manholes when required to remove collected debris.

G. Closing Abandoned Utilities: Close open ends of abandoned underground utilities which are indicated to remain in place.
   1) Provide sufficiently strong closures to withstand hydrostatic or earth pressure.
   2) Close open ends of concrete or masonry utilities with not less than eight inches brick masonry bulkheads.

H. Interior Inspection: Continually inspect conduits to determine whether line displacement or other damage has occurred during installation or backfill operations.
   1) Make inspections after lines between manholes, or manhole locations, have been installed and approximately two feet of backfill is in place and at completion of project. If inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, correct such defects to satisfaction of Engineer.

### 3.3 UNDERGROUND STRUCTURES

A. General: Structures to be pre-cast concrete unless specifically allowed and authorized in writing by Engineer.
   1) Where structures occur in pavements, set tops of frames and covers flush with finish surface. Elsewhere, set tops three inches above finish surface, unless otherwise indicated.
   2) Use epoxy-bonding compound where steps are mortared into structure walls.

B. Masonry Structures: Place as shown on drawings.
   1) At Contractor's option, use either sewer brick or concrete masonry units.
   2) Mix mortar with minimum water for workability. Re-tamping of mortar will not be permitted. Keep mortar mixing and conveying equipment clean. Do not deposit mortar upon, or permit contact with, ground.
   3) Lay masonry in mortar to form full bed with ends and side joints in one operation, and with full bed and vertical joints, not more than 5/8 inch wide. Protect fresh masonry from freezing and from rapid drying.
   4) Apply a 1/2-inch thick mortar coating on both interior and exterior wall surfaces.

C. Cast-In-Place Concrete Structures: Place as shown on drawings.

D. Precast Concrete Structures: Place as shown on drawings.
   1) Provide rubber joint gasket complying with ASTM C443. Grout inside of joints.

E. Connections: Connect to existing conduits and structures to will conform as nearly as practicable to requirements specified for new work.
   1) Prevent concrete or debris from entering existing conduit or structure. Remove debris, concrete or other extraneous material which may accumulate.

### 3.4 RIP-RAP

A. General: Place and arrange on geotextile fabric to form a compact layer to the lines and grades shown on plans and to specified thickness; plus or minus three inches.
   1) Place such that small pieces are not segregated but evenly distributed.

**3.5 DISPOSAL OF EXCESS AND WASTE MATERIALS -** comply with requirements of Section 30 00 00.

3.6 **TESTING AND INSPECTION REQUIREMENTS -** comply with requirements of Section 30 00 00.

## 4. OPERATION AND MAINTENANCE

### 4.1 GENERAL:

A. Maintain systems during construction to prevent depositions of sediments and debris into structures and sewers.

B. Inspect and remove any sediments and debris prior to placement into service.

C. Implement procedures to prevent unauthorized disposal or connection from sources such as chemicals, industrial wastes, flammables, or other products.
D. Inspect structures on a biannual basis for debris and blockages. Correct deficiencies.
E. Inspect complete system once every three years. Correct deficiencies.

# 5. MEASUREMENT AND PAYMENT

## 5.1 GENERAL

A. The contract unit price to be compensation in full for furnishing all materials, labor, equipment, tools and incidentals necessary for completion in every detail in accordance with plans and specifications.
   1) There will be no separate payment for clean up and restoration of property, or other items under this section unless specifically identified on the proposal, bid form, or contract.
B. Pipe: When payment is on a lineal basis, contract unit price for various sizes, types and depths of pipe to be compensation in full for one linear foot of pipe, complete and in place.
   1) Length of pipe to be measured horizontally from center of structures and ends of pipes; except, mitered end sections will be excluded in the length of concrete pipe.
C. Manholes, Junction Boxes and Inlets: When payment is on a per unit basis with depth of cut classifications, contract unit price to be compensation in full for one structure of various size, type and depth complete with frames and covers or grates, steps, inverts, connections and stub-outs in place.
   1) Depth of structure to be vertical distance from top of structure to invert.
D. Mitered End Sections: When payment is on a per unit basis, contract unit price for various sizes and types, including concrete pipe section, reinforcing, connections, anchors, concrete, sand, sod and incidentals necessary to be compensation in full for one mitered end section complete and in place.

**END OF SECTION 33 40 00**