

PROJECT MANUAL

SUFFOLK PUBLIC SCHOOLS



NORTHERN SHORES ELEMENTARY SCHOOL ADDITION
CONSTRUCTION PROJECT
DEPT. OF EDUCATION NO. 127-32-00-101

IFB # 1889-B

PROJECT MANUAL VOLUME 2 OF 2

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BID DOCUMENTS
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RRMM PROJECT NO. 23238-00

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and Section 230100 "Mechanical General Provisions" apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SCOPE

- A. The work includes the designing and providing of approved automatic wet-pipe sprinkler system for hazard occupancies indicated for complete coverage of the entire building additions.
- B. Contractor shall make connection to fire service main at a point 5'-0" outside of building unless otherwise noted on drawings. Areas of renovation shall be connected to the existing fire protection systems, or as indicated.
- C. All work shall conform to applicable portions of the latest edition of NFPA 13. Electrical work required by this Specification Section shall be accomplished in conformance with the requirements of the applicable Division 26 Specification Sections.
- D. All piping shall be concealed above ceilings. In areas with exposed construction, install piping as high as possible.

1.3 APPLICABLE SPECIFICATIONS, CODES AND STANDARDS

- A. Select equipment and materials from "List of Inspected Fire Protection Equipment and Materials" published annually by UL. Equipment shall bear UL approval stamp or label.

1.4 SUBMITTALS AND SHOP DRAWINGS

- A. Before any work is commenced, the Contractor shall submit a Revit model of the complete sprinkler system. The model submitted shall correctly and accurately depict the purposed layout of the sprinkler mains, branches, heads and all miscellaneous accessories. In addition, the Contractor shall submit a complete set of working drawings of the system, a partial submittal will not be reviewed. The submittal shall include the full descriptive data for riser check valves or riser manifold assemblies, gate valves, check valves, alarms, sprinkler heads,

hangers, and all other devices; materials and equipment as one complete package. Shop drawing resubmittals shall be returned as one complete package.

- B. Submit drawings, hydraulic calculations and flow test data having them approved by agency having jurisdiction before installation; obtain certificate of inspection and approval from same agency.

1.5 COMPUTER SIMULATED FLOW TEST

- A. Refer to Attached Hydraulic Analysis from the City of Suffolk Public Utilities.

1.6 WATER SOURCE FLOW TEST

- A. The Contractor shall obtain a flow test at the point at which the sprinkler system connects to the water source. The responsibility of obtaining the flow test and any costs associated with obtaining the flow test shall be borne by the Contractor. A copy of the test data shall be submitted along with the drawings and hydraulic calculations. Any flow test data given in the Contract documents is for the basis of obtaining a bid only and shall not be used by the Contractor for design purposes.
- B. Flow Data shall not be older than 12 months and a repeat testing shall be performed subsequent to any water infrastructure improvements, repairs or adjustments to the site water source.
- C. The Contractor shall be responsible for designing the sprinkler system to meet any and all pressure adjustments that the local authority having jurisdiction requires. These adjustments may be due to seasonal fluctuations in water pressure depending on the time of year that the flow tests are taken. Adjustments may also be required due to forecasts of future demands on the water source. The contractor shall obtain direction from the local authority at the time of requesting a water source flow test for all required adjustments and prior to performing hydraulic calculations and system design.

1.7 VERIFICATION OF EXISTING CONDITIONS

- A. The Contractor is responsible for verifying the size of all existing piping that will be used for the sprinkler system water source between the building and the point at which the flow test data is obtained. Provide hydraulic calculations for area of the existing building being fed from the existing fire protection system where indicated in Area B if required.

1.8 WARRANTY-GUARANTEE

- A. Contractor shall furnish written warranty, countersigned and guaranteed by the General Contractor, stating that the work executed under this Section of the Specifications shall be free from defects of materials and workmanship for a period of 12 months from Substantial Completion.

- B. Contractor shall service the systems for 12 months from date of Substantial Completion. Such service shall include all emergency services and adjustments.

PART 2 - PRODUCTS

2.1 SPRINKLER HEADS

- A. Sprinkler heads shall be automatic, closed, conventional type of ordinary degree temperature rating, except in locations near heaters where they shall be of high-temperature rating as required by NFPA 13.
- B. Furnish a supply of 12 extra sprinklers and one special sprinkler wrench. Supply shall include all types and ratings installed.
- C. Provide where directed one approved metal cabinet with hinged door for storing extra sprinklers and wrench.
- D. Provide upright sprinklers in areas without ceilings with standard brass finish.
- E. Provide recessed pendent sprinklers in areas with ceilings with bright chrome finish and chrome escutcheon plate.
- F. Provide UL Listed sprinkler guards on sprinklers which are exposed and subject to physical damage. This shall include, but not be limited to, storage rooms, mechanical rooms, electrical rooms and similar spaces.
- G. Extended coverage sprinkler heads may be used where allowed by Code.
- H. Sprinkler heads shall be STAR, VIKING, VICTAULIC, or approved equal.

2.2 ALARMS

- A. Provide water-actuated flow and electrically-actuated tamper switch alarms. Flow and tamper switch alarms shall be compatible with building fire alarm systems specified under Division 28. Alarm bell shall be provided by division 28.
- B. Provide flow switches at sprinkler riser.
- C. Provide tamper switches at each riser valve and zone valve, and backflow preventer valve.
- D. Coordinate with the existing fire alarm system the type of fire alarm system to be provided, and provide all material and labor necessary for the monitoring of the flow switches and tamper switches by the building fire alarm control panel. Final connections at the fire alarm control panel shall be accomplished under Division 28.

2.3 FLEXIBLE SPRINKLER HOSE FITTINGS

- A. As an option to rigid pipe connections in areas with acoustical tile ceilings and grids, flexible sprinkler hose fittings as manufactured by VIC FLEX, FLEXHEAD, or approved equal may be used.
- B. Hose fittings must be in accordance with NFPA 13 and must be FM Approved for its intended use pursuant to FM 1637 Approval Standard for Flexible Sprinkler Hose with Threaded End Fittings. Hose fittings must also be UL Listed for its intended use pursuant to UL 2443 Standard for Flexible Sprinkler Hose with Fittings for Fire Protection Service.
- C. Hose fittings shall be constructed of type 304 stainless steel.
- D. Drop system with union joints shall be factory pressure tested to 400 PSI.
- E. Hose fittings shall be leak tested, and must be listed for a minimum of (3) 90-degree bends.
- F. Hose fitting ceiling bracket shall be one-piece open gate.
- G. Hose fittings shall be direct attachment type, having integrated snap-on clip ends positively attached to the ceiling using tamper resistant screws.
- H. Flexible hose shall have minimum bend radius of 7" for FM and 3" for UL.

2.4 PIPE AND FITTINGS

- A. Provide piping above ground in accordance with NFPA 13, subject to the following:
 - 1. Non-metallic pipe shall not be allowed.
 - 2. The minimum wall thickness for steel pipe 2" and larger joined by welding or by roll-grooved pipe and fittings shall be in accordance with Schedule 10 pipe for pressures up to 300 psi. Threaded pipe and fittings 1-1/2" and smaller shall be Schedule 40.
- B. All underground piping and In-Building Riser shall be outside coated, ductile iron with mechanical joint utilizing ductile-iron retainer gland or ductile-iron flanges or shall be composed of a single extended 90-degree fitting of fabricated 304 stainless-steel tubing, maximum working pressure of 175 psi. The fittings shall have a grooved-end connection on the outlet (building) side and a cast-iron pipe size (CIPS) coupler on the underground (inlet) side.
- C. Fittings for ductile-iron pipe shall be of same class and coating as pipe.
- D. Joints for above ground pipe shall be threaded, flanged, or grooved VICTAULIC Firelock 005 or 009 couplings and fittings for rigid joint, or approved equal.
- E. Gaskets - VICTAULIC couplings shall be supplied with Grade E/Type A gaskets for wet sprinkler service and Flushseal for dry service.

- F. All grooved components (couplings, fittings, etc.) shall be of one manufacturer - Basis of Design – VICTAULIC COMPANY OF AMERICA.
- G. Couplings shall be installed per manufacturer's instructions. If a torque wrench is required, it shall be used.

2.5 VALVES

- A. Gate valves shall be iron body bronze mounted, solid wedge gate, rising stem, OS & Y for 175 psi CWP. JENKINS BROTHERS, Figure 824CJ. Valves shall be UL approved.
- B. Butterfly valves may be used in lieu of gate valves. Valves shall have ductile-iron body with nickel-plated ductile-iron disc, 416SS stem, Buna-N seat, suitable for 250 psi dead-end shut off and gear operator with position indicator. Valves shall be UL approved, VICTAULIC 705.

2.6 SUPPORTS, HANGERS AND INSERTS

- A. Support piping from building structure by means of hangers, inserts and other supports as per requirements of Section 230100, Paragraph 2.2. In addition to these requirements, hangers, including rods and clamps, shall be hot-dipped galvanized in all mechanical spaces, zinc plated in all interior spaces, except as otherwise specified. Refer to drawing SP-001 for sprinkler piping hanger details.

2.7 PIPE SLEEVES AND ESCUTCHEONS

- A. Provide sleeves to accommodate pipes passing through foundations, walls, floors and partitions. Sleeves shall be grouted in place in masonry walls and concrete floors. Refer to Section 230100 for additional requirements. Provide escutcheons at exposed finished surfaces pierced by pipes.

2.8 VALVE SEALS, SIGNS AND TAGS

- A. Seals: Provide UL-approved seals for all control valves sealed in open position.
- B. Signs: Provide identification signs of standard design; fasten securely at designated locations per NFPA.
- C. Tags: Provide brass tags 2" in diameter, stamp with designating numbers and secure with 12-gauge wire to spindle of control valves.

2.9 BACKFLOW PREVENTER

- A. Backflow preventer shall be double check valve type with butterfly valves and tamper switches. Backflow preventer shall be UL-, FM-approved. WILKINS 350-BG, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

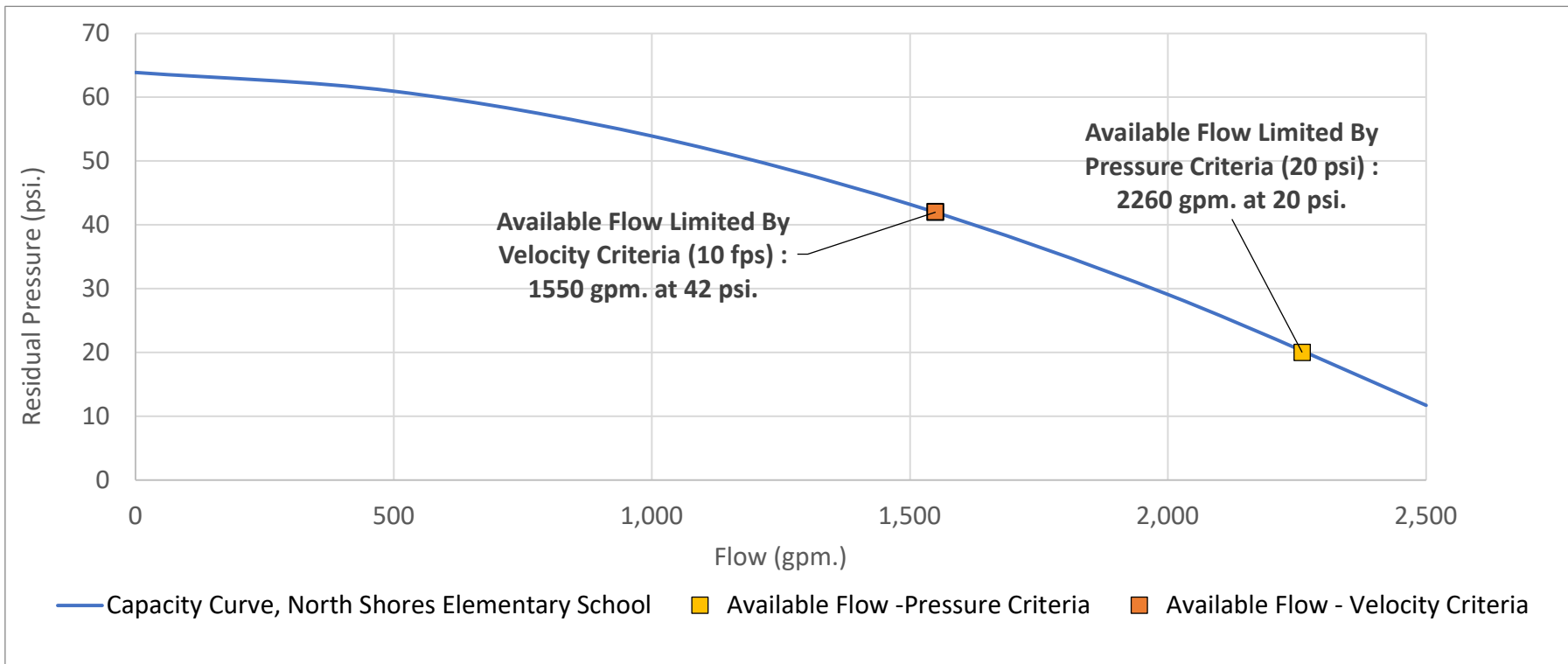
- A. Location and sizes of mains, risers, branches, valves and numbers of sprinkler heads shall be as required by codes, regulations and as approved.
- B. System shall be designed and installed to give full consideration to built-in and concealed spaces, piping, electrical equipment, ducts and all other construction and equipment to afford complete coverage and be free from operating and maintenance difficulties.
- C. Place sprinkler heads upward with deflectors parallel to roof except in areas with ceilings.
- D. Sprinkler head locations in areas with ceilings shall be coordinated with the Architect's reflected ceiling plans or shall be located as directed by Architect.
- E. In areas with lay-in acoustic tile ceilings, sprinkler heads shall be located in the center of the ceiling tiles, unless otherwise indicated.
- F. Install horizontal piping graded to low points and in manner to make possible to test and drain entire system. Test and drain locations shall be coordinated with the architect.

3.2 TEST

- A. Subject system to test required by and in presence of representative of agencies having jurisdiction. Details of test not covered by agencies' requirements shall be in accordance with NFPA 13.
- B. Conduct test required in presence of agencies having jurisdiction and in accordance with their instructions.
- C. Provide instruments, equipment and pay expenses incurred in making test.

END OF SECTION 211000

City of Suffolk Water Distribution System Modeled Capacity Curve (Peak Hour, Max Day Demand)



Node ID:

Test Node

Flow Capacity:

Available Flow Limited By
Velocity Criteria (10 fps) :
1550 gpm. at 42 psi.

Location:

6701 Repass Beach Rd

Pipe Information:

8" Stub
Diameter: 8-in.

Node Elevation (ft.):

14

Flow at 20 psi (gpm):

2260



JACOBS



Maximum allowable design velocity per City of Suffolk DPU Design and Construction Standards for fire flow is 10 fps. Accordingly, maximum capacity by pipe size is as follows:

| Diameter (inches) | Max Flow (gpm, at 10fps) |
|-------------------|--------------------------|
| 2 | 100 |
| 4 | 400 |
| 6 | 900 |
| 8 | 1550 |
| 10 | 2450 |
| 12 | 3550 |
| 14 | 4800 |
| 16 | 6250 |
| 18 | 7950 |
| 20 | 9800 |
| 24 | 14100 |

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SECTION 220500 - PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, Section 230100 "Mechanical General Provisions", and Section 230700 "Mechanical Insulation" apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SERVICE CONNECTIONS

- A. Contractor shall make all connections of building sewer to main and rain leaders to storm drain, at a point 5'-0" outside of building, unless otherwise noted on drawings. Connections for domestic water will be made within the building to the existing system.
- B. Make arrangements with local gas company for verification of existing gas meter site due to added gas demand.

1.3 PERMITS

- A. Contractor shall give all required notices and secure all necessary permits. Inspection certificates from local authorities having jurisdiction shall be delivered to the Architect prior to final payment.

1.4 GENERAL REQUIREMENTS

- A. Adhere to Virginia Plumbing Code, 2021 Edition, for minimum requirements; where drawings or specifications are at variance with Code, follow whichever provides for maximum size or condition.
- B. Verify all grades, elevations and utility connections before commencing work.
- C. Comply with requirements of the Uniform Federal Accessibility Standards (UFAS).
- D. All pipe, fittings and fixtures that are connected to potable water systems must meet the current Water Drinking Act and where applicable, meet NSF Standard 61 and be so labeled and be so certified. All plumbing valves, devices, fixtures and fittings shall be lead free.

1.5 SUBMITTALS AND SHOP DRAWINGS

A. Submit manufacturer's data on the following:

Plumbing Fixtures
Plumbing Fixture Supports
Faucets
Flush Valves
Balancing Valves
Supplies and Traps
Roof Drains
Overflow Roof Drains
Floor Drains
Cleanouts
Water Hammer Arrestors
Valves
Backflow Prevention Devices
Wall Hydrants
Hose Bibbs
Electric Water Heaters
Recirculating Pumps
Grease Interceptors
Solids Interceptor
Thermometers
Mixing Valves
ADA Pipe Covers
Thermal Expansion Tanks
Ice Maker Boxes
Waterless (Barrier Type) Trap Seal

B. Submit shop drawings on the following:

Grease Interceptors

C. Submit a schedule of all pipe materials to be used for each type of service.

1.6 WARRANTY-GUARANTEE

A. Contractor shall furnish written warranty, countersigned and guaranteed by the General Contractor, stating that work executed under this Section of the Specifications shall be free from defects of materials and workmanship for a period of 12 months from date of Substantial Completion.

B. During the guarantee period, the Contractor shall repair or replace defective material and workmanship and place same in working order to the satisfaction of the Architect at no additional expense to the Owner.

- C. Contractor shall service the systems for 12 months from date of Substantial Completion. Such service shall include all emergency services and adjustments, except cleaning of filters and screens.

PART 2 - PRODUCTS

2.1 SOIL, WASTE, DRAIN AND VENT PIPING

- A. Underground soil, waste, drain, rain leader and vent piping within the building and to a point 5'-0" outside of building foundation shall be centrifugally cast, coated Service Weight hub-and-spigot (ASTM A74), hubless cast-iron (ASTM A888), or DWV Schedule 40 PVC pipe (ASTM D2665) and fittings, unless otherwise noted.
- B. Underground foundation perforated drain piping shall be PVC D 2729 sewer pipe for drainage applications. Pipe shall be manufactured from virgin rigid PVC (polyvinyl chloride) vinyl compounds with a cell class of 12454 as identified in ASTM 1784. PVC D 2729 Sewer Pipe dimensions and physical properties shall conform to ASTM D 2729. Pipe shall be wrapped in filter fabric and embedded in minimum 6-inch stone all around.
- C. Above ground soil, waste, drain, rain leader and vent piping shall be hubless cast-iron pipe (ASTM A888), DWV copper pipe (ASTM B306) or DWV Schedule 40 PVC pipe (ASTM D2665) and fittings, except that PVC pipe shall not be used where piping penetrates fire partitions, or where rain leaders are exposed from floor to at least 10 feet above floor, or any location not allowed by the Virginia Uniform Statewide Building Code, 2021 Edition. PVC piping for any service shall not be installed in return air plenums. Cast iron shall be used in plenum spaces above ceilings and return air plenums.
- D. Foam Core PVC piping is not acceptable for any application.
- E. All underground soil, waste and drain piping in kitchen shall be centrifugally cast, coated Service Weight hub-and-spigot (ASTM A74), or hubless cast-iron (ASTM A888).
- F. Hub-and-spigot piping shall be assembled using plain-end spigot and positive double-seal elastomeric compression-type gasket joints above ground. Hubless pipe and fittings shall be assembled using Neoprene gasket and stainless-steel retaining sleeve. Underground hubless pipe and fittings shall be assembled per paragraph below. PVC pipe and fittings shall be assembled in strict accordance with manufacturer's instructions. Solvent cement shall conform to ASTM D2564.
- G. Hubless Cast-iron Pipe and Fittings - Below Grade: Joints shall be heavy duty, Factory Mutual approved, to FM 1680 Class 1, type 304 stainless-steel couplings with a shield thickness of .024 (24 gauge) with 125 in/lb. worm drive clamps with Neoprene gaskets conforming to ASTM C564. Couplings 1-1/2" to 4" in diameter shall be 3" wide and have two clamps. Couplings 5" to 10" in diameter shall be 4" wide and have four clamps. Couplings 12" and 15" wide shall be 5-5/8" wide and have six clamps. Model HI-TORQ 125 as manufactured by CLAMP-ALL PRODUCTS, IDEAL CLAMP PRODUCTS, or approved equal.

- H. Condensate drain piping underground shall be Schedule 40 PVC (ASTM D2665) or hubless cast-iron pipe.

2.2 CLEANING PLUGS AND TEST TEES

- A. Provide cleanouts as indicated and/or required by the Virginia Plumbing Code, 2021 Edition.
- B. Cleanouts shall be the same size as pipe, up to 4". Cleanouts for pipes larger than 4" shall be sized in accordance with the Virginia Plumbing Code, 2021 Edition. Cleanouts installed in connection with cast-iron, hub-and-spigot pipe shall consist of longsweep 1/4 bends or one or two 1/8 bends extended to easily accessible, approved location or where indicated. Extra-heavy cast-brass ferrule with cast-brass cleanout plug shall be caulked into hub of fittings and shall be flush with floor. Cleanouts in connection with threaded pipe shall be cast-iron drainage T-pattern 90-degree branch fittings with extra-heavy brass screw plugs of the same size as pipes, up to and including 4". Install test tees with cast-iron cleanout plugs at foot of soil, waste and drain stacks and on each building drain outside building. Where cleanouts occur on pipe concealed in partitions and walls, provide with chromium-plated cast-brass plate secured to brass plugs. Verify cleanout locations before pipe installation. Extend cleanout plugs to within 1" of finished wall.
- C. See paragraph FIXTURES AND EQUIPMENT for cleanout access covers.
- D. Cleanouts indicated outside of building shall be flush with grade and have concrete pad as specified in Section 230100.

2.3 TRAPS

- A. Provide a trap for each fixture and piece of equipment requiring connections to drainage system. Supply traps with fixtures. Place each trap as near fixture as possible and no fixture shall be double trapped. Traps installed on threaded pipe shall be recess drainage pattern. Trap on all floor drains shall be deep-seal type.
- B. Provide waterless (Barrier-type) trap seal devices on floor drains as indicated on plans. Trap seals by GREEN DRAIN, PROSET or approved equal.
- C. Exposed traps and drain piping shall be chromium plated.

2.4 WATER PIPING

- A. Water piping shall be copper tubing, Type K, hard-tempered underground and Type L, hard-tempered above ground. Piping shall be assembled with wrought-copper fittings using 95-5 solder above ground and silver solder underground.
- B. Press Connector Fittings:
 - 1. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and NSF/ANSI Standard (NSF 61). Sealing elements

- for press fittings shall be factory installed EPDM.
2. Press-connected fittings 1/2" – 2" press end shall have a leak-before-press feature, which assures leakage from inside the system past the sealing element of an unpressed connection. Fittings 2-1/2" – 4" press end shall have a factory installed means for visual inspection of completed press. Copper press fitting joints shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tuning marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark in the tubing to ensure the tubing is fully inserted in the fitting. The joints shall be pressed using the pressing tool and jaws or jaw set, approved by the fitting manufacturer. Fitting installer shall be trained by the fitting manufacturer's factory representative.
 3. Press connected fittings shall be by ELKHART PRODUCTS CORP., NIBCO, VIEGA or approved equal.
- C. Exposed water piping located in finished areas shall be chromium plated or stainless steel where materials are available. For larger pipe sizes, pipe may be painted.
- D. Grooved construction may be utilized with engineer approval on above ground copper service 2-1/2" and larger. Couplings shall be copper tubing sized installation ready Style 607. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by Victaulic. Grooved butterfly valves, Series 608, may be used on grooved copper tubing systems. Grooving tools shall be supplied by the same manufacturer as the grooved components. Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove. A Victaulic factory trained field representative shall provide on-site training to contractor's field personnel in the installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.
- E. Provide water hammer arrestors on hot and cold water supply piping to fixtures as indicated and/or required to prevent water hammer. Arrestors shall be factory-fabricated with stainless steel shell, hydro-pneumatic cushion of nitrogen, stainless steel bellows, and stainless-steel male threaded pipe nipples. Water hammer arrestor shall be sized in accordance with Plumbing and Drainage Institute WH201. JOSAM, ZURN or SMITH may be used.
- 2.5 GAS PIPING
- A. Gas piping above ground 1/2" through 2" shall be Schedule 40 black steel screw fabricated using malleable-iron fittings and piping 2-1/2" and over shall be fabricated by welding using Schedule 40 steel welding fittings. Gas piping and fittings exposed to the weather shall be Schedule 40 galvanized steel. Paint all joints in galvanized piping with galvanized paint.
 - B. Provide shut-off valves on gas mains, risers and branches where indicated and at connection to all gas-burning equipment.

2.6 VALVES

- A. Provide valves on piping as indicated and as required to isolate fixtures and equipment and to give complete control of water in risers and branch lines. Valves shall be ball, unless otherwise indicated. All valves shall be lead-free.
- B. No cast-iron valves shall be used on domestic hot water piping. Valves shall be bronze or brass body valves only.
- C. Valves on copper water piping, up to and including 2", shall be bronze or brass. Valves on cold or chilled piping shall have extended shafts to match the pipe insulation thickness to prevent condensation. Catalog numbers indicated are NIBCO. Valves with equivalent characteristics by APOLLO or MILWAUKEE are acceptable.

| <u>Type</u> | <u>Size</u> | <u>Catalog Number</u> |
|-------------|----------------|-----------------------|
| Ball | 2-1/2" - 3" | S-FP-600A-LF |
| Ball | 2" and smaller | S-585-80-LF |
| Check | 2" and smaller | S-413-Y-LF |

- D. Reduced Pressure Principle Backflow Preventers: (No Lead)

| <u>Size</u> | <u>Catalog Number</u> |
|----------------|--------------------------------------|
| 2" and smaller | 975 XL2-S w/strainer where indicated |

Provide air gap fitting. WILKINS catalog models indicated, or approved equal.

- E. Washing Machine Valve Box: GUY GRAY CO. Enamel-coated steel box with angle gate valves with handles. Recessed in wall where indicated.
- F. Ice Maker Box: GUY GRAY CO. Enamel-coated steel box with bronze supply valve with handle. Recessed in wall where indicated.
- G. All gas valves 3" and smaller shall be bronze body, threaded with bronze trim ball valves. Gas valves shall be UL-Listed. Valves shall be as manufactured by NIBCO model T-585-70-UL, or approved equal.

2.7 VENTURI FLOW MEASURING AND BALANCING VALVES

- A. Provide venturi flow measuring and balancing valves where indicated, NUTECH Model MB for pipe size 1/2" to 2" and Model MBF for sizes 2-1/2" and larger, or approved equal.
- B. Balancing valves 1/2" thru 2" shall be constructed of bronze or brass. Valves shall be rated for 600 psi at 250°F. The valve ball ID shall be minimum standard port (one size smaller than valve connection size) Reduced port valves are not acceptable.
- C. Venturi section shall be low loss with a minimum accuracy of 3% of rate.

- D. Valves shall be provided with pressure/temperature ports and memory stop. Valves shall be equipped with metal tag and chain. Valves shall be supplied with extended handles and PT ports to clear insulation on chilled water service.
- E. Valves shall be sized as indicated or as recommended by valve manufacturer for intended flow capacity.

2.8 MIXING VALVES

- A. Provide complete mixing valves as indicated and scheduled on contract documents. Mixing valves shall meet ASSE standards for intended use as listed below. LEONARD numbers indicated, equal by POWERS or BRADLEY.
 - 1. ASSE 1017: Hot Water Distribution Systems
 - 2. ASSE1070: Hand Lavatory

2.9 FIXTURES AND EQUIPMENT

- A. Provide complete fixtures and equipment indicated and scheduled on contract documents. Fixtures and equipment shall be as manufactured by the listed manufacturers below or approved equal. The plumbing fixtures listed below are selected to establish examples of design intent and to set a standard of quality. Equivalent fixtures and fittings from other manufactures may be submitted for approval.
 - 1. Vitreous china fixtures shall be as manufactured by KOHLER, AMERICAN STANDARD, or SLOAN.
 - 2. Stainless steel sinks shall be as manufactured by JUST, ELKAY, or ADVANCED TABCO.
 - 3. Manual faucets shall be as manufactured by CHICAGO, T&S BRASS, or MOEN.
 - 4. Manual flush valves shall be as manufactured by SLOAN, ZURN, or DELANY.
 - 5. Terrazzo mop sinks shall be as manufactured by STERN WILLIAMS, FLORESTONE, or FIAT.
 - 6. Drinking fountains and electric water coolers shall be as manufactured by HALSEY TAYLOR, ELKAY, or OASIS.
- B. All material shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
- C. Provide supply stops as required for all fixtures. Refer to plumbing drawings for additional fixture information.
- D. Provide concealed, floor-mounted, fixture support carriers for all wall-mounted plumbing fixtures, including: urinals, lavatories and water coolers. Provide floor-mounted supports with concealed arms for wall-hung lavatories. Carriers shall be as manufactured by J. R. SMITH CO., or approved equal. Contractor to select proper model to suit wall construction.
- E. All water coolers and drinking fountains are to be lead-free.

- F. Provide Owner with any special tools required to perform maintenance on fixtures and fittings.
- G. Wall hydrants shall be freezeless type, Model 65 satin-chrome finish, with loose key handle, vacuum breaker and backflow preventer. WOODFORD MFG. CO. Contractor to select proper model to suit wall construction.
- H. Exterior hose bibbs shall be WOODFORD MFG. CO., Model 19, with die cast aluminum handle. Brass construction, chromium plated, with vacuum breaker-backflow preventer.
- I. Roof drains and overflow roof drains shall be type indicated, coated cast-iron body with extension as required, roof sump receiver and dual deck plate with securing brackets. Drain shall have combination membrane flashing clamp/gravel guard and low-silhouette aluminum dome.
- J. Floor drains shall be type indicated, cast-iron body with nickel bronze strainers. Where waterproof membranes occur, provide clamping collar. SMITH numbers indicated. ZURN or JOSAM may be used.
- K. Provide nickel-bronze cleanout access. Where waterproof membranes occur, provide clamping collar. SMITH numbers indicated. ZURN or JOSAM may be used.

| | |
|-----------------------|--------|
| Resilient tile floor | 4020-U |
| Painted masonry walls | 4402 |
| Ceramic tile floor | 4020-U |
| Carpeted floors | 4020-Y |
| Terrazzo floors | 4020-U |
| Concrete floors | 4020-U |

2.10 COMMERCIAL ELECTRIC WATER HEATERS

- A. Provide electric water heaters of size, type and capacity as indicated. A.O. SMITH, STATE, RUDD or approved equal.
- B. Units shall be listed by Underwriters' Laboratories and approved to the NSF Standard 5 by UL. Models shall meet or exceed the standby loss requirements of the U.S. Department of energy and current edition of ASHRAE/IESNA 90.1. Heater(s) shall have 150 psi working pressure.
- C. All internal surfaces of the heater(s) exposed to water shall be glass-lined with an alkaline borosilicate composition that has been fused to steel by firing at a temperature range of 1400°F to 1600°F.
- D. Electric heating elements shall be medium watt density with zinc plated copper sheath. Each element shall be controlled by an individually mounted thermostat and high temperature cutoff switch. Where indicated by model number, electric heating elements shall be 24K Goldenrod medium watt density screw-in type with Incoloy sheath and ceramic terminal block. Internal power circuit fusing shall be provided. Element operation shall be linear

sequencing through individual magnetic contactors. Control circuit shall be factory fused and include an immersion thermistor temperature probe with built in ECO control.

- E. Where indicated by model number, water heater shall have LCD display with built-in diagnostic and troubleshooting information and shall incorporate the iCOMM™ system for remote monitoring, leak detection and fault alert.
- F. The outer jacket shall be of backed enamel finish and shall be provided with full size control compartment for performance of service and maintenance through hinged front panels and shall enclose the tank with foam insulation.
- G. Electrical junction box with heavy duty terminal block shall be provided. The drain valve shall be located in the front for ease of servicing.
- H. Heater tank shall have a three-year limited warranty as outlined in the written warranty.

2.11 HOT WATER CIRCULATING PUMPS

- A. In-line pumps shall be close-coupled all bronze construction with mechanical seals. Motor shall be open drip-proof. BELL & GOSSETT, or approved equal.
- B. Refer to mechanical drawings for control sequences and points list required for pump operation.

2.12 THERMOMETERS

- A. Thermometers shall be provided as indicated. WEKSLER INSTRUMENT, Type "AF".
- B. Thermometers in pipelines shall be separable socket 5" dial bi-metal insertion type, with scale suitable for temperature range of medium being measured. Thermometers shall be located to facilitate reading from floor. Angle type shall be used where necessary to facilitate reading. Install thermal well in flow of fluid.
- C. Thermometer range shall be 0-200°F for hot water.

2.13 GREASE INTERCEPTOR

- A. Provide unit of size, type and capacity as indicated. MIFAB or approved equal.
- B. The tank shall be an underground, double basin tank made of fiberglass. The tank shall be manufactured with a 4" inlet and outlet.
- C. Provide traffic rated manways flush with finished grade for access to tank for maintenance.
- D. Grease interceptor shall be installed in accordance with plans and manufacturer's recommendations.

2.14 THERMAL EXPANSION TANK

- A. Provide a bladder type thermal expansion tank as manufactured by AMTROL, Model THERM-X-TROL or approved equal.
- B. The expansion tank shall be welded steel, constructed, tested and stamped in accordance with section VIII, Division 1 of the ASME Code for a working pressure of 125 PSIG, factory air pre-charged and field adjustable. All welds conforming to ASME Section IX. All internal parts must comply with FDA regulations and approvals.
- C. Each tank shall have a steel shell and an internal butyl/EPDM diaphragm to isolate the air charge from fluid.

2.15 ELEVATOR SUMP PUMP

- A. Provide an automatic submersible dewatering pump for the elevator sump pit. Pumps shall be as manufacturer by ZOELLER or approved equal.
- B. Construction shall be of cast iron with 100% baked-on powder coated epoxy finish for corrosion resistance and longer casting durability. All fasteners and external metal parts shall be of stainless steel. Impeller shall be of vortex non-clog design.
- C. The pump shall be a hermetically sealed, submersible type, operating in a high quality dielectric oil for cooling the windings and for lubrication of the motor bearings and ceramic-carbon shaft seal.
- D. Single phase motor shall have internal automatically resetting, thermal overload protection and shaded pole motor.
- E. Oil Smart® Controls – Provide Oil Smart pump switch to control water pumps in elevator sump. Switch shall include internal 20 amp relay and 304 stainless steel sensor probes. Provide pump control and alert system with Oil Smart Technology that shall alert residents or maintenance personnel of liquid level problems.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

- A. Grade horizontal soil, waste and drain pipes as follows, except as approved and as indicated on drawings:

| | |
|---------------|------------------------|
| 2" | 1/4" per foot, minimum |
| 3" and larger | 1/8" per foot, minimum |
- B. Install vertical soil and waste piping with provision for expansion and extend full size to and above roof lines as vents, except as otherwise indicated. Where practicable, connect two or

more vent pipes together and extend as one pipe through roof at approved locations. Run concealed vent pipes in overhead spaces with horizontal waste or soil piping pitched down to stacks without forming traps in pipes, using required fittings. Where an end or circuit vent pipe from fixture or line of fixture is connected to vent line serving other fixtures, make the connection at least 4'-0" above the floor on which fixtures are located. Vent lines shall not be used as waste, except as approved. Extend cast-iron hub-and-spigot pipe inside of building 6" above the floor.

- C. Make changes in pipe sizes on soil, waste and drain lines with reducing fittings or recessed reducers. Make changes in direction by appropriate use of 45-degree wyes, longsweep 1/6, 1/8, or 1/16 bends, except sanitary tees may be used where permitted by code in soil and waste lines where change in direction of flow is from horizontal to vertical and on discharge from water closets. Short-radius fittings shall not be permitted, except in approved location.
- D. Slip joints are permitted only in trap seals or on inlet side of traps. Use hub fittings for making union connections wherever practicable, in connection with dry vents.
- E. PVC piping shall not be installed in return-air plenums, through fire walls, or any location not allowed by the 2021 Virginia Uniform Statewide Building Code.
- F. All flow measuring and balancing valves shall be balanced for flow indicated by Plumbing Contractor.
- G. Provide pipe sleeves, hangers, supports, and fixture supports. Contractor shall be responsible for proper and permanent location. Pipe shall not be permitted to pass through footings, beams, or ribs. All piping passing through all walls shall be sleeved and insulation shall run continuously through sleeve. Install pipe sleeves and properly secure in place with grout where pipes pass through all walls and at all fire-rated assemblies. Pipe sleeves, except in footings, shall be sufficient diameter to provide approximately 1/4" clearance around insulation or pipe. Fill void between insulation or pipe and sleeve with mineral wool to prevent sound transmission.
- H. Pipe sleeves through foundation walls shall be cast iron, 4" larger in diameter than pipe installed. Pipe sleeves in walls, floors, and partitions shall be Schedule 40 steel pipe. Extend sleeves above floor at least 1", pack space around pipe with fireproof material, and make watertight. Pipe penetrations through below grade exterior walls shall be sealed with modular seals selected for the type of pipe and wall penetration, "LINK SEAL" or equal. Where pipes pass through waterproofing membranes, provide flashing sleeves with integral flashing flanges or clamping device of 16-ounce soft-sheet copper; extend at least 8" from sleeve. Thoroughly mop flashing flanges and shields into membrane.

3.2 CONNECTIONS TO EQUIPMENT

- A. Make plumbing connections to all equipment requiring connections, including equipment in Contract and equipment furnished by others. Make all connections according to manufacturer's recommendations.
- B. Provide hot water, cold water, waste, vent, floor drains and indirect waste for kitchen and other Owner-furnished equipment. Drawings are not intended to be complete in every respect

concerning these items. Provide all manufacturer's recommended valves, unions, arrestors, regulators, etc., as required by manufacturer.

3.3 FIXTURE SETTING HEIGHTS

- A. Plumbing fixtures shall be at heights indicated and/or directed. Heights of handicapped plumbing fixtures shall be as governed by the 2021 Virginia Uniform Statewide Building Code, ANSI A117.1, and the requirements of the Uniform Federal Accessibility Standards (UFAS).

3.4 INSPECTION AND TESTS

- A. The new plumbing system shall be tested by the Contractor in the presence of the Architect. Governing authorities having jurisdiction shall be notified of test required by them and Final Acceptance of work shall be contingent upon their approval. At least 48 hours' notice shall be given prior to test. All costs of conducting test and furnishing necessary equipment for test shall be borne by the Contractor.
- B. The new soil, waste, drain and vent system shall be tested and proved tight prior to connection of fixtures, by closing all openings, except highest at roof and filling with water to point of overflow. Allow water to stand at least 2 hours before starting inspection. Where piping must be tested in sections to facilitate construction, include at least the upper 10 feet of the preceding section so that no pipe or joint in building will have been subjected to less than 10 feet head of water. Piping laid in trenches shall not be backfilled until test has been made and joints proved tight. Owner shall be provided 24 hours' notice prior to tests and provided written results of tests.
- C. Upon completion of roughing-in and before setting fixtures, test new hot and cold water piping system at hydrostatic pressure of 100 psig and prove watertight at this pressure. Test water piping system to be concealed separately in same manner as prescribed for entire system.
- D. Thoroughly clean and flush piping and apply chlorine solution to new system at least 3 hours to destroy nonspore-forming bacteria. Following chlorination, flush agent from system until water is both bacteriologically and chemically satisfactory to Public Health Officer.
- E. If inspection or tests show defect, replace such defective work or materials and repeat inspection tests. Make repairs to piping with new materials. No caulking of screwed joints or holes shall be acceptable.
- F. Test all gas piping at 50 psig with oil-free compressed air for 2 hours with no loss in pressure.
- G. Clean equipment, pipe, valves and fittings of grease, metal cuttings and sludge accumulated by operations of system for testing. Stoppage or discoloration or other damage to parts of building, its finish or furnishings due to Contractor's failure to properly clean piping system shall be repaired without cost to the Owner.

- H. All domestic hot water flow measuring and balancing valves shall be balanced for flow indicated in the contract documents by the Plumbing Contractor. Balanced flow shall be reported in the final TAB Report.

3.5 TESTING

- A. The Contractor shall test the domestic water supply system to the new school for the presence of lead and copper action levels in the system prior to connection to the building. The Contractor shall be responsible for providing an interior water system that meets the requirements set forth in the Environmental Protection Agency's "Lead and Copper Rule", December 7, 1991, as adopted by the Virginia Department of Health. After the building is connected, cleaned and flushed, the domestic water shall be tested for the presence of lead and copper action levels at Contractor's expense. Samples shall be taken in the kitchen and at water coolers, drinking fountains, sinks and bubblers. All outlets in the building used for drinking water or food preparation shall not exceed the 15 ppb for lead and the 1.3 ppm for copper action levels as set forth by the above standard. If improper lead and copper action levels are detected, the Contractor shall isolate portions of the piping system to determine the source, correct the problem and retest at his expense. The Contractor shall continue testing, re-testing and corrective measures until the system is free of lead or copper contamination at or above the action levels. All re-testing and corrections shall be done at the Contractor's expense.

END OF SECTION 220500

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SECTION 221113 - FACILITY WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including general and supplementary conditions and division 01 specification sections, apply to this section.

1.2 SUMMARY

- A. This section includes water-distribution piping and related components outside the building for water service and fire-service mains.

1.3 DEFINITIONS

- A. PVC: polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Detail vault assemblies and indicate dimensions, method of field assembly, and components.
 - 1. Wiring Diagrams: Power, signal, and control wiring for alarms.

1.5 QUALITY ASSURANCE

- A. Regulatory requirements:
 - 1. Codes and Standards: Comply with the City of Newport News Waterworks Department including: tapping of water mains and backflow prevention, potable-water-service piping, including materials, installation, testing, and disinfection, fire-suppression water-service piping, including materials, hose threads, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.
- D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
- E. NFPA compliance: comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
- F. NSF compliance:

1. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-PW" on piping.

- G. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.6 PROJECT CONDITIONS

- A. Interruption of existing water-distribution service: do not interrupt service to facilities occupied by owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:

1. Notify architect no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without architect's written permission.

1.7 COORDINATION

- A. Coordinate connection to water main in accordance with the City of Newport News Waterworks Department.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.
 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
- B. Hard Copper Tube: ASTM B 88, Type K, water tube, drawn temper.
 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
- C. Mechanical-joint, ductile-iron pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 1. Mechanical-joint, ductile-iron fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 2. Glands, gaskets, and bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- D. Push-on-joint, ductile-iron pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Push-on-joint, ductile-iron fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 2. Gaskets: AWWA C111, rubber.
- E. Grooved-joint, ductile-iron pipe: AWWA C151, with cut, rounded-grooved ends.
1. Grooved-end, ductile-iron pipe appurtenances:
 - a. Available manufacturers: subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - 1) Anvil International, Inc.
 - 2) Victaulic Company of America.
 - b. Grooved-end, ductile-iron fittings: ASTM a 47/a 47m, malleable-iron castings or ASTM a 536, ductile-iron castings with dimensions matching pipe.
 - c. Grooved-end, ductile-iron-piping couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
- F. PE, Fire-Service Pipe: ASTM F 714, AWWA C906, or equivalent for PE water pipe; FMG approved, with minimum thickness equivalent to FMG Class 200.
1. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.
- G. PVC, AWWA pipe: AWWA C900, class 150, with bell end with gasket, and with spigot end.
1. Comply with UL 1285 for fire-service mains if indicated.
 2. PVC fabricated fittings: AWWA C900, class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 3. PVC molded fittings: AWWA C907, class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 4. Push-on-joint, ductile-iron fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Gaskets: AWWA C111, rubber.
 5. Mechanical-joint, ductile-iron fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Glands, gaskets, and bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.2 JOINING MATERIALS

- A. Refer to Division 22 section "Common Work Results for Plumbing" for commonly used joining materials.
- B. Brazing filler metals: AWS A5.8, BCuP series.
- C. Bonding adhesive for fiberglass piping: as recommended by fiberglass piping manufacturer.
- D. Plastic pipe-flange gasket, bolts, and nuts: type and material recommended by piping system manufacturer, unless otherwise indicated.

2.3 PIPING SPECIALTIES

- A. Transition fittings: manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- B. Tubular-sleeve pipe couplings:
 - 1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
 - a. Standard: AWWA C219.

2.4 GATE VALVES

- A. AWWA, cast-iron gate valves: shall be in accordance with The City of Newport News Waterworks Department.
 - 1. Available manufacturers: subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, the following:
 - a. American AVK Co.; Valves & Fittings Div.
 - 2. Nonrising-stem, metal-seated gate valves:
 - a. Description: gray- or ductile-iron body and bonnet; with cast-iron or bronze double-disc gate, bronze gate rings, bronze stem, and stem nut.
 - 1) Standard: AWWA C500.
 - 2) Minimum pressure rating: 200 psig.
 - 3) End connections: mechanical joint.
 - 4) Interior Coating: complying with AWWA C550.
 - 3. Nonrising-stem, resilient-seated gate valves:
 - a. Description: gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
 - 1) Standard: AWWA C509.
 - 2) Minimum pressure rating: 200 psig.
 - 3) End connections: mechanical joint.
 - 4) Interior coating: complying with AWWA C550.

4. Nonrising-stem, high-pressure, resilient-seated gate valves:
 - a. Description: ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.
 - 1) Standard: AWWA C509.
 - 2) Minimum pressure rating: 250 psig.
 - 3) End connections: push on or mechanical joint.
 - 4) Interior coating: complying with AWWA C550.
5. OS&Y, rising-stem, metal-seated gate valves:
 - a. Description: cast- or ductile-iron body and bonnet, with cast-iron double disc, bronze disc and seat rings, and bronze stem.
 - 1) Standard: AWWA C500.
 - 2) Minimum pressure rating: 200 psig.
 - 3) End connections: flanged.
6. OS&Y, rising-stem, resilient-seated gate valves:
 - a. Description: cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.
 - 1) Standard: AWWA C509.
 - 2) Minimum pressure rating: 200 psig.
 - 3) End connections: flanged.

2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

- A. Tapping-sleeve Assemblies: shall be in accordance with The City of Newport News Waterworks Department.
 1. Available manufacturers: subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
 - b. East Jordan Iron Works, Inc.
 - c. Flowserve.
 - d. Mcwane, Inc.; Clow Valve Co. Div. (Oskaloosa).
 - e. Mcwane, Inc.; Kennedy Valve Div.
 - f. Mcwane, Inc.; M & H Valve Company Div.
 - g. Mueller Co.; Water Products Div.
 - h. U.S. Pipe and Foundry Company.
 2. Description: sleeve and valve compatible with drilling machine.
 - a. Standard: MSS SP-60.
 - b. Tapping sleeve: cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
 - c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

- B. Valve boxes: shall be in accordance with The City of Newport News Waterworks Department and comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "water," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.
 - 1. Operating wrenches: steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
- C. Indicator posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.6 CORPORATION VALVES AND CURB VALVES

- A. Shall be in accordance with The City of Newport News Waterworks Department
- B. Manufacturers:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. [Amcast Industrial Corporation; Lee Brass Co.](#)
 - b. [Ford Meter Box Company, Inc. \(The\); Pipe Products Div.](#)
 - c. [Jones, James Company.](#)
 - d. [Master Meter, Inc.](#)
 - e. [McDonald, A. Y. Mfg. Co.](#)
 - f. [Mueller Co.; Water Products Div.](#)
 - g. [Red Hed Manufacturing & Supply.](#)
- C. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.
 - 1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
 - 2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
- D. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.
- E. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches in diameter.
 - 1. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

2.7 WATER METERS

- A. Shall be in accordance with The City of Newport News Waterworks Department.
- B. Water meters will be furnished by utility company.

2.8 DETECTOR-TYPE WATER METERS

- A. Shall be in accordance with The City of Newport News Waterworks Department.

2.9 BACKFLOW PREVENTERS

- A. Reduced-pressure-principle backflow preventers:
 - 1. Available manufacturers: subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - a. Ames Fire & Waterworks; A Division of Watts Regulator Co.
 - b. Conbraco Industries, Inc.
 - c. Febco; SPX Valves & Controls.
 - d. Flomatic Corporation.
 - e. Watts Water Technologies, Inc.
 - f. Wilkins; A Zurn Company.
 - 2. Standard: AWWA C511.
 - 3. Operation: continuous-pressure applications.
 - 4. Pressure loss: 12 psig maximum, through middle 1/3 of flow range.
 - 5. Size: 1.5-inch
 - 6. Body: bronze for NPS 2 and smaller.
 - 7. End connections: threaded for NPS 2 and smaller.
 - 8. Configuration: designed for horizontal, straight through flow.
 - 9. Accessories:
 - a. Valves: ball type with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - b. Air-gap fitting: ASME a112.1.2, matching backflow preventer connection.
- B. Reduced-pressure-detector, fire-protection backflow preventer Assemblies:
 - 1. Available manufacturers: subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - a. Ames Fire & Waterworks; A Division of Watts Regulator Co.
 - b. Conbraco Industries, Inc.
 - c. Febco; Spx Valves & Controls.
 - d. Watts Water Technologies, Inc.
 - e. Wilkins; A Zurn Company.
 - 2. Standards: ASSE 1047 and UL listed or FMG approved.
 - 3. Operation: continuous-pressure applications.
 - 4. Pressure loss: 12 psig maximum, through middle 1/3 of flow range.
 - 5. Size: 8-inch

6. Body: cast iron with interior lining complying with AWWA C550 or that is FDA approved.
7. End connections: flanged.
8. Configuration: designed for horizontal, straight through flow.
9. Accessories:
 - a. Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
 - b. Air-gap fitting: ASME a112.1.2, matching backflow preventer connection.
 - c. Bypass: with displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

2.10 WATER METER BOXES

- A. Description: Shall be in accordance with The City of Newport News Waterworks Department. Cast-iron body and cover for disc-type water meter, with lettering "water meter" in cover; and with slotted, open-bottom base section of length to fit over service piping.

2.11 PROTECTIVE ENCLOSURES

- A. Freeze-protection enclosures:
 1. Available manufacturers: subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - a. Aqua Shield.
 - b. Bf Products, Inc.
 - c. Dekorra Products.
 - d. Dunco Manufacturing, Inc.
 - e. G&C Enclosures.
 - f. Hot Box, Inc.
 - g. Hydrocowl, Inc.
 - h. Watts Water Technologies, Inc.
 2. Description: insulated enclosure designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of 40 deg f when external temperatures reach as low as minus 34 deg f.
 - a. Standard: ASSE 1060.
 - b. Class I: for equipment or devices other than pressure or atmospheric vacuum breakers.
 - c. Class I-V: for pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
 - 1) Housing: reinforced-aluminum or stainless steel construction.
 - a) Size: of dimensions indicated, but not less than those required for access and service of protected unit.
 - b) Drain opening for units with drain connection.
 - c) Access doors with locking devices.
 - d) Insulation inside housing.
 - e) Anchoring devices for attaching housing to concrete base.

- 2) Electric heating cable or heater with self-limiting temperature control.

2.12 FIRE HYDRANTS

- A. Fire hydrants shall be in accordance with The City of Newport News Waterworks Department.

- B. Dry-barrel fire hydrants:

1. Available manufacturers: subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - a. American Avk Co.; Valves & Fittings Div.
 - b. American Cast Iron Pipe Co.; American Flow Control Div.
 - c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
 - d. American Foundry Group, Inc.
 - e. East Jordan Iron Works, Inc.
 - f. Mcwane, Inc.; Clow Valve Co. Div. (Oskaloosa).
 - g. Mcwane, Inc.; Kennedy Valve Div.
 - h. Mcwane, Inc.; M & H Valve Company Div.
 - i. Mueller Co.; Water Products Div.
 - j. Troy Valve; A Division of Penn-Troy Manufacturing, Inc.
 - k. U.S. Pipe and Foundry Company.
2. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
 - a. Standard: AWWA C502.
 - b. Pressure rating: 150 psig minimum.

- C. Wet-barrel fire hydrants:

1. Available manufacturers: subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - a. American AVK Co.; Valves & Fittings Div.
 - b. Jones, James Company.
 - c. Mcwane, Inc.; Clow Valve Co. Div. (Corona).
 - d. Mcwane, Inc.; Clow Valve Co. Div. (Oskaloosa).
 - e. Mueller Co.; Water Products Div.
2. Description: freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, NPS 6 threaded or flanged inlet, and base section with NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550.
 - a. Standard: AWWA C503.
 - b. Pressure rating: 150 psig minimum.

2.13 FIRE DEPARTMENT CONNECTIONS

- A. Fire department connections:
 - 1. Available manufacturers: subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - a. Elkhart Brass Mfg. Co., Inc.
 - b. Fire End & Croker Corporation.
 - c. Guardian Fire Equipment, Inc.
 - d. Kidde Fire Fighting.
 - e. Potter Roemer.
 - f. Reliable Automatic Sprinkler Co., Inc.
 - 2. Description: Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- high brass sleeve; and round escutcheon plate.
 - a. Standard: UL 405.
 - b. Connections: two NPS 2-1/2 inlets and one NPS 4 outlet.
 - c. Inlet alignment: inline, horizontal.
 - d. Finish including sleeve: polished chrome-plated.
- B. Escutcheon plate marking: "AUTO SPKR & STANDPIPE."

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Refer to Division 31 section "Earth Moving for Sitework" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. General: use pipe, fittings, and joining methods for piping systems according to the following applications.
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- C. Do not use flanges or unions for underground piping.
- D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- E. Underground water-service piping NPS 3/4 to NPS 3 shall be any of the following:
 - 1. PVC, schedule 80 pipe; PVC, schedule 80 socket fittings; and solvent-cemented joints.

- F. Underground water-service piping NPS 4 to NPS 8 shall be any of the following:
 - 1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
 - 2. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.
 - 3. PVC, schedule 40 pipe; PVC, schedule 40 socket fittings; and solvent-cemented joints.
 - 4. NPS 4 and NPS 6: NPS 6 PVC, AWWA class 150 pipe; PVC, AWWA class 150 fabricated fittings; and gasketed joints.
 - 5. NPS 8: PVC, AWWA class 200 pipe; PVC, AWWA class 200 fabricated, push-on-joint, ductile-iron, mechanical-joint, ductile-iron fittings; and gasketed joints.
- G. Water meter box water-service piping NPS 3/4 to NPS 2 shall be same as underground water-service piping.
- H. Underground fire-service-main piping NPS 4 to NPS 12 shall be any of the following:
 - 1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.
 - 2. PVC, AWWA class 150 pipe listed for fire-protection service; PVC class 150 fabricated or molded fittings; and gasketed joints.

3.3 VALVE APPLICATIONS

- A. General application: use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.
- B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Underground valves, NPS 3 and larger: AWWA, cast-iron, nonrising-stem, resilient-seated gate valves with valve box.
 - 2. Underground valves, NPS 4 and larger, for indicator posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.

3.4 PIPING INSTALLATION

- A. Water-main connection: connect to existing on-site plugged water line.
- B. Comply with NFPA 24 for fire-service-main piping materials and installation.
- C. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

1. Install PE corrosion-protection encasement according to ASTM a 674 or AWWA C105.
- D. Install PVC, AWWA pipe according to ASTM f 645 and AWWA M23.
- E. Bury piping with depth of cover over top at least 36-inches, with top at least 12 inches below level of maximum frost penetration, and according to the following:
 1. Under driveways: with at least 36 inches cover over top.
 2. In loose gravelly soil and rock: with at least 12 inches additional cover.
- F. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
 1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
- G. Install underground piping with both restrained joints and thrust blocks at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
- H. See Division 21 Section "Fire-suppression Systems" for fire-suppression-water piping inside the building.
- I. See Division 22 Section "Plumbing Piping" for potable-water piping inside the building.

3.5 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:
 1. Ductile-iron piping, gasketed joints for water-service piping: AWWA C600 and AWWA M41.
 2. Ductile-iron piping, gasketed joints for fire-service-main piping: UL 194.
 3. Ductile-iron piping, grooved joints: cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
 4. PVC piping gasketed joints: use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM d 2774 or ASTM d 3139 and pipe manufacturer's written instructions.
 5. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - a. Dielectric fittings for NPS 2 and smaller: use dielectric nipples.
 - b. Dielectric fittings for NPS 2-1/2 to NPS 4 : use dielectric nipples.
 - c. Dielectric fittings for NPS 5 and larger: use dielectric flange kits.

3.6 ANCHORAGE INSTALLATION

- A. Anchorage, general: install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 - 1. Concrete thrust blocks.
 - 2. Locking mechanical joints.
 - 3. Set-screw mechanical retainer glands.
 - 4. Bolted flanged joints.
 - 5. Pipe clamps and tie rods.
- B. Install both mechanical joint restraints and thrust blocks at all tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
 - 1. Gasketed-joint, ductile-iron, water-service piping: according to AWWA C600.
 - 2. Gasketed-joint, PVC water-service piping: according to AWWA M23.
 - 3. Bonded-joint fiberglass, water-service piping: according to AWWA M45.
 - 4. Fire-service-main piping: according to NFPA 24.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.7 VALVE INSTALLATION

- A. AWWA gate valves: comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. AWWA valves other than gate valves: comply with AWWA C600 and AWWA M44.
- C. UL/FMG, gate valves: comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- D. UL/FMG, valves other than gate valves: comply with NFPA 24.

3.8 WATER METER INSTALLATION

- A. Water meters: install displacement -type water meters, NPS 2 and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.
- B. Water meters: install compound -type water meters, NPS 3 and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
- C. Water meters: install detector-type water meters in meter vault according to AWWA M6. Include shutoff valves on water meter inlets and outlets and full-size valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

3.9 ROUGHING-IN FOR WATER METERS

- A. Rough-in piping and specialties for water meter installation according to utility company's written instructions.

3.10 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
- C. Do not install bypass piping around backflow preventers.
- D. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.11 WATER METER BOX INSTALLATION

- A. Install water meter boxes in grass or earth areas with top 2 inches above surface.

3.12 PROTECTIVE ENCLOSURE INSTALLATION

- A. Install concrete base level and with top approximately 2 inches above grade.
- B. Install protective enclosure over valves and equipment.
- C. Anchor protective enclosure to concrete base.

3.13 FIRE HYDRANT INSTALLATION

- A. General: install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B. Wet-barrel fire hydrants: install with valve below frost line. Provide for drainage.
- C. AWWA fire hydrants: comply with AWWA M17.
- D. UL/FMG fire hydrants: comply with NFPA 24.

3.14 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install ball drip valves at each check valve for fire department connection to mains.

3.15 CONNECTIONS

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

- B. Connect water-distribution piping to existing water main.
- C. Connect water-distribution piping to interior domestic water and fire-suppression piping.
- D. Ground equipment according to division 26 section "grounding and bonding for electrical systems."
- E. Connect wiring according to division 26 section "low-voltage electrical power conductors and cables."

3.16 FIELD QUALITY CONTROL

- A. Piping tests: conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic tests: test at not less than one-and-one-half times working pressure for two hours.
 - 1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
- C. Prepare reports of testing activities.

3.17 IDENTIFICATION

- A. Install continuous underground detectable trace wire during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in division 31 section "Earth Moving for Sitework."
- B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel.

3.18 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
 - 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
 - 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.

3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
 - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
 - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
 - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
- B. Prepare reports of purging and disinfecting activities.

END OF SECTION 221113

SECTION 221313 - FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Comply with The City of Suffolk, Department of Public Utilities.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Nonpressure and pressure couplings.
 - 3. Expansion joints and deflection fittings.
 - 4. Backwater valves.
 - 5. Cleanouts.
 - 6. Encasement for piping.
 - 7. Manholes.

1.3 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Expansion joints and deflection fittings.
 - 2. Backwater valves.
- B. Shop Drawings: Include plans, elevations, sections, details, and frames and covers.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Architect's written permission.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

- A. Pipe: ASTM A 746, for push-on joints.
- B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
- C. Compact Fittings: AWWA C153, ductile iron, for push-on joints.
- D. Gaskets: AWWA C111, rubber.

2.2 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS

- A. Push-on-Joint Piping:
 1. Pipe: AWWA C151.
 2. Standard Fittings: AWWA C110, ductile or gray iron.
 3. Compact Fittings: AWWA C153.
 4. Gaskets: AWWA C111, rubber, of shape matching pipe and fittings.
- B. Mechanical-Joint Piping:
 1. Pipe: AWWA C151, with bolt holes in bell.
 2. Standard Fittings: AWWA C110, ductile or gray iron, with bolt holes in bell.
 3. Compact Fittings: AWWA C153, with bolt holes in bells.
 4. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
 5. Gaskets: AWWA C111, rubber, of shape matching pipe, fittings, and glands.

2.3 PVC PIPE AND FITTINGS

- A. PVC Gravity Sewer Piping:
 1. Pipe and Fittings: ASTM F 679, T-1 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.
- B. PVC Pressure Piping:
 1. Pipe: AWWA C900, Class 150 PVC pipe with bell-and-spigot ends for gasketed joints.
 2. Fittings: AWWA C900, Class 150 PVC pipe with bell ends.
 3. Gaskets: ASTM F 477, elastomeric seals.

2.4 NONPRESSURE-TYPE TRANSITION COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
 - 1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Unshielded, Flexible Couplings:
 - 1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
- D. Shielded, Flexible Couplings:
 - 1. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- E. Ring-Type, Flexible Couplings:
 - 1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
- F. Nonpressure-Type, Rigid Couplings:
 - 1. Description: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling, molded from ASTM C 1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.5 PRESSURE-TYPE PIPE COUPLINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cascade Waterworks Mfg.
 - 2. Dresser, Inc.
 - 3. Ford Meter Box Company, Inc. (The); Pipe Products Div.
 - 4. JCM Industries, Inc.
 - 5. Romac Industries, Inc.
 - 6. Smith-Blair, Inc.; a Sensus company.
 - 7. Victaulic Depend-O-Lok, Inc.
 - 8. Viking Johnson.
 - 9. Approved equal.
- B. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.

- C. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 150-psig minimum pressure rating and ends of same sizes as piping to be joined.
- D. Center-Sleeve Material: Manufacturer's standard.
- E. Gasket Material: Natural or synthetic rubber.
- F. Metal Component Finish: Corrosion-resistant coating or material.

2.6 EXPANSION JOINTS AND DEFLECTION FITTINGS

- A. Ductile-Iron, Flexible Expansion Joints:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. EBAA Iron, Inc.
 - b. Romac Industries, Inc.
 - c. Star Pipe Products.
 - 2. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.
- B. Ductile-Iron Expansion Joints:
 - 1. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for expansion indicated.
- C. Ductile-Iron Deflection Fittings:
 - 1. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for up to 15 degrees of deflection.

2.7 BACKWATER VALVES

- A. Cast-Iron Backwater Valves:
 - 1. Manufacturers: Subject to compliance with requirements.
 - 2. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
 - 3. Horizontal type; with swing check valve and hub-and-spigot ends.
 - 4. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.

5. Terminal type; with bronze seat, swing check valve, and hub inlet.

B. PVC Backwater Valves:

1. Manufacturers: Subject to compliance with requirements.
2. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

2.8 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Top-Loading Classification(s): Light Duty and Heavy Duty.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts:

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.9 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Material: high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.

C. Form: Sheet or tube.

D. Color: Black.

2.10 MANHOLES

A. Manholes shall be in accordance with the City of Suffolk, Department of Public Works.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch- minimum-width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SEWER."
2. Material: ASTM A 48/A 48M, Class 35 gray iron unless otherwise indicated.

C. Manhole-Cover Inserts:

**NORTHERN SHORES ELEMENTARY SCHOOL ADDITION
SUFFOLK PUBLIC SCHOOLS**

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1. Description; Manufactured of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
2. Type: Solid.

2.11 CONCRETE

- A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 1 percent through manhole.
2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 4 percent.

- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving for Sitework."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Install gravity-flow, nonpressure, drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow, at minimum slope of 0.40 percent unless otherwise indicated.
 - 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
 - 3. Install piping with 36-inch minimum cover.
 - 4. Install ductile-iron, gravity sewer piping according to ASTM A 746.
 - 5. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
- G. Install force-main, pressure piping according to the following:
 - 1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
 - 2. Install piping with 36-inch minimum cover.
 - 3. Install ductile-iron pressure piping according to AWWA C600 or AWWA M41.
 - 4. Install ductile-iron special fittings according to AWWA C600.
 - 5. Install PVC pressure piping according to AWWA M23 or to ASTM D 2774 and ASTM F 1668.
 - 6. Install PVC water-service piping according to ASTM D 2774 and ASTM F 1668.
- H. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:
 - 1. Ductile-iron pipe and fittings.
 - 2. Expansion joints and deflection fittings.
- I. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
 2. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
 3. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.
- B. Join force-main, pressure piping according to the following:
1. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.
 2. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
 3. Join PVC pressure piping according to AWWA M23 for gasketed joints.
 4. Join dissimilar pipe materials with pressure-type couplings.
- C. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
 - a. Shielded flexible or rigid couplings for pipes of same or slightly different OD.
 - b. Unshielded, increaser/reducer-pattern, flexible or rigid couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
 2. Use pressure pipe couplings for force-main joints.

3.4 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Install FRP manholes according to manufacturer's written instructions.
- D. Form continuous concrete channels and benches between inlets and outlet.
- E. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.
- F. Install manhole-cover inserts in frame and immediately below cover.

3.5 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.6 BACKWATER VALVE INSTALLATION

- A. Install horizontal-type backwater valves in piping manholes or pits.

- B. Install combination horizontal and manual gate valves in piping and in manholes.
- C. Install terminal-type backwater valves on end of piping and in manholes. Secure units to sidewalls.

3.7 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 - 1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
 - 2. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.8 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."
- B. Connect force-main piping to building's sanitary force mains specified in Division 22 Section "Sanitary Waste and Vent Piping." Terminate piping where indicated.
- C. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
 - a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.9 IDENTIFICATION

- A. Materials and their installation are specified in Division 31 Section "Earth Moving for Sitework."
 1. Install continuous underground detectable trace wire during backfilling of trench for underground sanitary sewer piping. Locate below finished grade, directly over piping.

3.10 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 1. Submit separate report for each system inspection.
 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate report for each test.
 5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
 - a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
 - b. Close openings in system and fill with water.
 - c. Purge air and refill with water.

- d. Disconnect water supply.
 - e. Test and inspect joints for leaks.
 - 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
 - b. Option: Test concrete gravity sewer piping according to ASTM C 924.
 - 7. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig .
 - a. Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
 - b. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
 - 8. Manholes: Perform hydraulic test according to ASTM C 969.
 - C. Leaks and loss in test pressure constitute defects that must be repaired.
 - D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
- 3.11 CLEANING
- A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 221313

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SECTION 230100 - MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. This Section forms a part of all Division(s) 21, 22 and 23 Sections.
- C. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 APPLICABLE SPECIFICATIONS, CODES AND STANDARDS

- A. Latest effective publications of following Specifications, regulations, standards, codes, etc., as applicable, form a part of these Specifications the same as if written fully herein and shall be followed as minimum requirements.

Codes and ordinances of local governing agencies:

| | |
|--------|---|
| AGA | American Gas Association |
| AHRI | Air Conditioning, Heating and Refrigeration Institute |
| AMCA | Air Moving and Conditioning Association |
| ANSI | American National Standard Institute |
| ASHRAE | American Society of Heating, Refrigerating and Air-conditioning Engineers |
| ASME | American Society of Mechanical Engineers |
| ASTM | American Society for Testing and Materials |
| IEEE | Institute of Electrical and Electronics Engineers |
| VFGC | Virginia Fuel Gas Code (NFPA 54), 2021 Edition |
| VMC | Virginia Mechanical Code, 2021 Edition |
| VPC | Virginia Plumbing Code, 2021 Edition |
| NEC | National Electrical Code (NFPA 70), 2020 Edition |
| NEMA | National Electrical Manufacturers Association |
| NFPA | National Fire Protection Association |
| OSHA | Occupational Safety and Health Administration |
| SMACNA | Sheet Metal and Air-conditioning Contractors National Association |
| UFAS | Uniform Federal Accessibility Standards |
| UL | Underwriters Laboratories, Inc. |
| VUSBC | Virginia Uniform Statewide Building Code, 2021 Edition |

1.3 DRAWINGS

- A. General arrangements of indicated piping, ductwork and equipment are diagrammatic only, do not scale. Where rearrangement is necessary, submit drawings of proposed changes for approval. Due to scale of drawings, offsets, fittings and accessories may not be indicated. Work indicated, but having details omitted, shall be provided complete to perform function intended without extra cost. Investigate existing structural and finish conditions in building affecting plumbing, heating, ventilating and air-conditioning work, etc., and arrange work accordingly. Furnish fittings, traps, offsets, vents, valves and accessories required. Install equipment in accordance with manufacturer's recommendations and clearance requirements.

1.4 COORDINATION

- A. Coordinate piping, ducts and equipment with electrical, structural, and architectural plans and work in order to avoid omissions and to eliminate any interference. Report in writing discrepancies, if found, to the Engineer as soon as possible after discovery.

1.5 WORKMANSHIP

- A. Workmanship shall be first class and of best quality in accordance with approved contemporary construction practices. Defective equipment and materials, or material damaged in the course of installation and tests shall be replaced or repaired in an approved manner.

1.6 CUTTING

- A. Cutting shall be carefully done. Repair damage to the building, piping, wiring, or equipment as a result of cutting for installation, using skilled mechanics of trade involved.

1.7 APPROVAL OF MATERIALS, FIXTURES AND EQUIPMENT

- A. See Specification Section 013300 "Submittal Procedures", for shop drawing submittal procedures. Within 30 days after award of the Contract and before any purchases are made, submit for approval a complete list of materials, fixtures and equipment proposed, together with names of manufacturers and catalog numbers for each Specification Section. Furnish other detailed information where directed. No consideration will be given to partial lists submitted from time to time. Approval of materials shall be based on manufacturer's published ratings. Materials, fixtures and equipment listed which are not in accordance with specified requirements shall be rejected. Contractor shall make resubmission of items not approved within 30 days from date of rejections. Submission shall be complete with description, ratings, dimensions and related items and any additional information required by the Engineer.
- B. Materials and equipment shall be new, conforming to these Specifications.

- C. Two or more units of same class of equipment shall be product of single manufacturer; however, component parts of system need not be product of same manufacturer.
- D. Mechanical design has given full consideration to space requirements for equipment specified. Contractor is responsible for selecting equipment that will be accommodated by this space. Equipment not conforming to space allotted shall be rejected.
- E. Mechanical design has given full consideration for electrical requirements for equipment. Contractor is responsible for selecting equipment that will be accommodated by the electrical design indicated. Equipment not conforming to the electrical design provided under Division 26 is the Contractor's responsibility. All electrical changes required to accommodate the equipment provided shall be furnished and installed by the Contractor without change in Contract price or time of completion. This shall include but not be limited to wiring, conduit, circuit breakers, disconnect switches, and controllers.
- F. Submit one copy of equipment installation manuals to the Engineer for their use.
- G. Contractor shall submit automatic temperature controls package specified in 230900 prior to equipment packages specified in 230500.

1.8 EQUIPMENT DESIGN

- A. Equipment and accessories not specifically described or identified by manufacturer's catalog numbers shall be designed in conformity with ASME, ANSI, IEEE, or other applicable technical standards, suitable for maximum working pressure and shall have neat and finished appearance.

1.9 SUPERVISION

- A. The Contractor for each Section under this Division shall maintain a competent foreman on the job at all times to supervise the work and coordinate with other trades for the installation of the system. Submit foreman's qualifications, including master's trade license, to the Engineer for approval.

1.10 NOTICES AND FEES

- A. Give all required notices, obtain all necessary permits and pay all required fees.

1.11 RECORD DRAWINGS

- A. Refer to Specification Section 017839 "Project Record Documents".

1.12 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Specification Section 017823 "Operation and Maintenance Data".

1.13 OWNER'S TRAINING

- A. Upon completion of work and at a time designated by the Owner, the services of competent persons shall be provided as required to instruct Owner's representative in operation and maintenance of systems. Training sessions shall be a combination of on-site and in-classroom training and shall be a minimum of two 8-hour sessions. All training shall be video recorded by the Contractor and provided to the Owner in electronic format.

1.14 WARRANTY-GUARANTEE

- A. Contractor shall furnish written warranty, countersigned and guaranteed by the General Contractor, stating that work executed under this Section of the Specifications shall be free from defects of materials and workmanship for a period of 12 months from date of Substantial Completion.
- B. Contractor shall service the systems for 12 months from date of Substantial Completion. Such service shall include all emergency services and adjustments, including cleaning/changing of filters. Adjustments and repairs to equipment shall be made by the original equipment manufacturer (OEM). Third party service agencies are not acceptable for making repairs or adjustments to equipment during the warranty period.
- C. The equipment manufacturer and Contractor shall provide a one-year material, labor and refrigerant warranty on all compressors. In addition, the manufacturer shall provide a material only warranty on all compressors for a period of 6 years total, beginning at the date of Substantial Completion.
- D. Contractor shall be responsible for all maintenance, repair and servicing of mechanical equipment during the construction and warranty period as required by the equipment manufacturers and identified in the Operation and Maintenance Manuals. This shall include all routine maintenance, such as greasing of bearings, adjustment/replacement of belts, cleaning of coils, calibration of controls and other routine maintenance items that may be unique to each piece of equipment. This shall also include repair and replacement of any malfunctioning or damaged parts. In addition, this shall include changing filters on a bi-weekly basis through award of Substantial Completion and on a monthly basis during the warranty period. Where pre-filters and final filters are used in a system, the final filters shall only require replacement once, at the end of the warranty period, as long as the pre-filters have been changed as specified. Upon the Owner's observation that this work is not being performed by the Contractor, the Owner will arrange to have these services performed and shall deduct the associated costs from the contract amount or back charge the Contractor for services performed. Monthly service logs shall be forwarded by the Contractor to holders of the operation and maintenance manuals. Contractor shall respond within 24-hour notification by Owner or General Contract.

PART 2 - PRODUCTS

- 2.1 PIPE SLEEVES, PIPE HANGERS, PIPE SUPPORTS, DUCT SUPPORTS AND FIXTURE SUPPORTS
- A. Provide pipe sleeves, hangers, supports, duct supports and fixture supports. Contractor shall be responsible for proper and permanent location. Pipe and duct shall not be permitted to pass through footings, beams, or ribs, unless indicated and/or approved. All piping passing through all walls shall be sleeved and insulation shall run continuously through sleeve. Install pipe sleeves and properly secure in place with grout where pipes pass through all walls and at all fire-rated assemblies. Pipe sleeves, except in footings, shall be sufficient diameter to provide approximately 1/4" clearance around insulation or pipe. Fill void between insulation or pipe and sleeve with mineral wool to prevent sound transmission.
 - B. Pipe sleeves in footings or foundation walls shall be cast iron, 4" larger in diameter than pipe installed. Pipe sleeves in walls, floors (including first floor slab on grade), partitions, and slab on grade shall be Schedule 40 steel pipe. Extend sleeves above floor at least 1", pack space around pipe with fireproof material and make watertight. Pipe penetration through below grade exterior walls shall be sealed with modular seals selected for the type of pipe and wall penetration, "LINK SEAL" or approved equal. Where pipes pass through waterproofing membranes, provide flashing sleeves with integral flashing flanges or clamping device of 16-ounce soft-sheet copper; extend at least 8" from sleeve. Thoroughly mop flashing flanges and shields into membrane.
 - C. Hang horizontal overhead runs of pipe with adjustable clevis-type hangers spaced not over 10 feet apart, except space soil pipe hangers not over 6 feet apart. Provide hangers other than aforementioned, if pipe size or other features make spacing at shorter intervals necessary. Pipe hangers shall be provided within 4 feet of all changes in direction of pipe. Pipe hangers shall not be installed on pipe fittings where fitting could bear the weight of connected pipe but instead shall be installed on pipe at intervals previously specified. Chain, strap, perforated bar, or wire hanger will not be permitted. Hangers shall have short turnbuckles or approved means of adjustment. Use spring-type hangers where required. Use trapeze hangers on pipes running parallel and close together. Support vertical runs of pipe by clamps or collars spaced not over 20 feet apart or as required, except cast-iron soil or waste pipe shall be supported at every floor. Support chromium-plated pipe where required by cast-brass supports finished to match pipe. Hangers for copper tubing shall be copper plated where in contact with tubing. Hangers, including rods and clamps, shall be hot dipped galvanized exterior to the building, in all mechanical spaces, and when supporting fire protection piping. Hangers shall be zinc plated in all interior spaces, except as otherwise specified.
 - D. Hang all horizontal overhead runs of pre-insulated refrigerant pipe with a pipe shield as manufactured by EATON B-LINE, series SNAP'N SHIELD or approved equal. Hang all horizontal overhead runs of field insulated refrigerant piping with a clamp assembly attached to strut as manufactured by EATON B-LINE, series B-LINE ARMAFIX CLAMPS or approved equal. Refrigerant pipe insulation shall be continuous through the clamp assembly. All refrigerant pipe supports shall be spaced not over 6 feet apart.
 - E. Gas piping, refrigeration piping and condensate piping on roof shall be supported by support blocks manufactured by ROOF TOP BLOX model RTB-01, or approved equal. The support

blocks shall be designed to eliminate roof penetrations, flashings or damage to roofing membrane. Support body shall be made of recycled UV-resistant Polypropylene Copolymer. Base platform material shall be 1" thick, 25 psi, Type 4 closed cell structural foam to distribute and evenly cushion loads. Support top surface shall have molded in pipe organizing saddles and strut mounting cradle. The top surface shall also have screw guide indents and engineered internal screw thread gripping feature. Block shall accept up to 1/2" threaded rod using side entry nut slots to allow fast top side assembly and piping height adjustments or attachment of galvanized slotted steel strut channel. All support block hardware shall be hot dipped galvanized. Supports for roof mounted gas piping shall be provided with a galvanized roller and collar assembly, "ROL-05" for pipe sizes up to 3", "ROL-06" for pipe sized 4" through 6". For roof mounted piping, provide approved pipe supports every four feet for Polyvinyl Chloride (PVC), every six feet for Copper, and every ten feet for gas piping.

- F. Supports for piping, ductwork and equipment shall be attached to a structural member, not bridging. Piping, ductwork and equipment shall not be attached to structural joist bridging or metal roof or floor decking. Provide additional steel supports spanning between trusses, joists or beams for hanger attachments. Additional steel supports shall be approved by the Structural Engineer. Refer to details on the drawings for hanging from trusses.
- G. In areas supported by steel beams, secure hanger rods directly to beams.
- H. Support vertical lines from lowest story with base fittings set on concrete or brick pier or by hangers and supports where directed.
- I. Provide galvanized steel shields or protection saddles to protect insulation at area of contact with hangers and supports. Where shields are used on pipes 1-1/2" and larger, provide insulation inserts at points of hangers and supports. Refer to Specification Section 230700 "Mechanical Insulation", for details.
- J. Support and fasten fixtures and equipment in an approved manner.
- K. Ductwork shall be supported in accordance with SMACNA, HVAC Duct Construction Standards, unless otherwise noted or indicated. Ductwork shall be supported using threaded rod or solid metal strap as required by SMACNA. No other materials, such as perforated metal strap, or cloth strap, are acceptable. Wire may be used to hang round duct smaller than 10"; however, solid metal strap shall be used to wrap around duct. Wire shall not be used for rectangular duct or round duct larger than 10".

2.2 DUCT AND PIPE PENETRATIONS THROUGH FLOORS, WALLS AND CEILINGS

- A. Fit exposed pipes passing through floors, finished walls, or finished ceilings with escutcheon of chromium-plated cast-brass plates on chromium-plated pipe, nickel-plated steel plates on ferrous pipe, or copper tubing. Plates shall be large enough to completely close hole around pipes and conceal pipe sleeves and shall be round, with least dimension at least 1/2" larger than diameter of pipe and insulation. Secure plates in an approved manner.
- B. Fit ductwork passing through floors, walls, or ceilings with 22-gauge galvanized sheet-metal sleeves. Sleeves shall be large enough to completely close hole around duct and shall be at least 1/2" larger than outside dimensions of duct and insulation. Provide flanges on both sides

of penetrations to cover the wall edge. For uncovered ducts, sleeves shall be of same material as duct. Secure sleeves and flanges in an approved manner.

- C. Fit ductwork passing through roof membrane with a 12" insulated 18-gauge galvanized roof curb. Provided flashing, counter flashing at duct and roof penetrations.
- D. Through penetrations of fire rated partitions, firewalls, smoke partitions, or floors shall be sealed using an approved firestop system in accordance with ASTM E814 or UL1479. Firestop systems utilized shall be equal to or greater than the fire resistance rating of the penetrated partition. Applicable penetrations include but are not limited to: metallic pipe/conduit/tube, nonmetallic pipe/conduit/tube, cable/cable bundle, cable tray, electrical busway, ductwork, hydronic piping, and refrigerant piping. Basis of design for firestop systems shall be HILTI, or equal by STI or 3M.

2.3 UNIONS

- A. Unions shall be installed on each side of all control valves, regulators and similar items and one side of all pieces of equipment, such as pumps, tanks, etc., so that such equipment shall be readily disconnected and removed if necessary.

2.4 DIELECTRIC CONNECTIONS

- A. Dielectric connections shall be provided at all connections between ferrous and nonferrous piping or metals, except drain piping connections at drain pans for cooling coils and valves having cast-bronze adapters.

2.5 ELECTRICAL WORK FOR EQUIPMENT UNDER MECHANICAL SYSTEMS

- A. All non-integrated motor controllers serving equipment installed under Division 23 Sections shall be furnished under those Sections and shall be turned over to Electrical Contractor, for installation by Electrical Contractor. Controllers shall be equipped with all auxiliary contacts, poles, or devices necessary to permit interlocking and control required.
- B. Fractional horsepower motors 1/2 HP and below shall be single-phase, 60 cycles, 120V; motors larger than 1/2 HP shall be 3-phase, 60 cycles, of voltages indicated on the electrical drawings and conforming to the electrical service, except where indicated otherwise. Motors shall conform to latest NEMA requirements.
- C. All electrical power wiring required for equipment installed under Division 23 Sections shall be provided under Division 26 Sections with all necessary approved wiring diagrams and guidance provided under Division 23 Sections, except for power wiring to Automatic Temperature Control panels which shall be provided by the Automatic Temperature Control Contractor.
- D. Raceways shall be 1/2" minimum. All wiring in rooms with exposed structure or in inaccessible ceiling and walls shall be installed in conduit. Label the front face of the cover on each junction box with indelible black marker indicating the number of each circuit

contained in or running through the box. In areas where exposed construction is the final finished condition and conduit and junction boxes are called out to be painted, label the inside face of the covers.

- E. All control and power wiring required for temperature control system and all interlocking and accessory control wiring required for equipment installed under Division 23 Sections shall be installed by the Plumbing, Mechanical and Temperature Control Contractors.
- F. All controls shall be NEMA rated and NEMA I enclosed where mounted inside building, except in kitchens which shall be NEMA 4X-SS. Controls mounted outside or where specifically called for shall be NEMA 3R.
- G. Auxiliary 120-Volt contacts shall be provided to give control and interlocking as required or as indicated.
- H. The Contractor shall be responsible for coordinating with the Division 26 Contractor for providing properly sized circuit breakers to serve equipment and motors furnished which differ from that specified or indicated. This shall be further understood to include branch circuit wiring, conduit, disconnect switches, etc., in accordance with the appropriate codes and specifications. The cost of providing this increased electrical service and related work shall be included under the applicable section under which the equipment and motors are being furnished, at no additional cost to Owner.
- I. The Automatic Temperature Controls Contractor shall be responsible for providing circuit breakers and power wiring and conduit from electrical panels installed under Division 26 to Automatic Temperature Controls panels. All electrical work shall be in accordance with appropriate codes and Division 26 specifications.
- J. The Mechanical Contractor shall be responsible for the installation and mounting of all duct smoke detectors in new and existing ductwork. The duct smoke detector shall be furnished and provided with all fire alarm wiring under Division 28. Any and all Temperature Control wiring shall be provided under Division 23. Refer to the mechanical drawings for locations in new ductwork. Refer to the electrical drawings for locations of existing detectors to be replaced. Coordinate the installation of the detectors with the Electrical and Automatic Temperature Control Contractors.
- K. Short-Circuit Current Rating (SCCR) on HVAC equipment nameplates:
 - 1. The nameplate for all HVAC equipment shall be provided with SCCR in accordance with the National Electric Code (NEC) Article 440.4(B). The SCCR shall meet or exceed the SCCR indicated on the contract documents.
- L. The Mechanical Contractor shall coordinate the following electrical requirements with the Electrical Contractor prior to ordering any equipment:
 - 1. Number of electrical connections
 - 2. Number and size of feeder conductors
 - 3. Number and size of feeders' terminal lugs
 - 4. Maximum overcurrent protection
 - 5. Size and type of fuses

2.6 MACHINERY ACCESSORIES

- A. Provide oil-level gages, grease cups and grease-gun fittings for machinery bearings as recommended by machinery manufacturer; where these lubricating means are not easily accessible, extend to locations as directed. Furnish all grease-gun fittings of uniform type.

2.7 WALL, PARTITIONS AND CEILING ACCESS DOORS

- A. The Contractor shall furnish and the General Contractor shall install access doors with lock where required, style necessary for surface in which placed, sizes as indicated or required for access to equipment, valves, dampers, filters, duct smoke detectors and all other devices requiring access. Access doors shall be at least 18" x 18".
 - 1. Access doors in ceilings shall be ACUDOR "UF-5000" or equal. Finish shall be prime coat steel.
 - 2. Access doors in walls shall be ACUDOR "UF-5000" or equal. Finish shall be Type 304 stainless steel with #4 satin polish.
- B. Access doors shall have same fire rating as ceiling, floors, walls and partitions in which installed.
 - 1. Access doors in fire-rated ceilings shall be ACUDOR "FWC-5015" or equal. Finish shall be satin coat steel.
 - 2. Access doors in fire rated walls shall be ACUDOR "FC-5015" or equal. Finish shall be satin coat steel.

2.8 AIR BALANCING DEVICES

- A. Furnish any additional material or equipment, such as sheaves, belts, motors and balancing devices, required to complete and/or adjust and balance the systems as recommended by the TAB Agency at no additional cost to the Owner. Failure to provide additional means of adjusting and balancing will not relieve the Contractor of responsibility for properly adjusting and balancing the various systems as intended.

2.9 DUCT SEALANT

- A. Where duct is indicated to be sealed, utilize a fire resistive, water based, indoor/outdoor, U.V. resistant, non-fibrated duct sealant, DUCTMATE EverSeal, FOSTER DUCT-FAS 32-19 or approved equal.
- B. Sealant shall have a volatile organic compound (VOC) rating of 24 g/L, less water.
- C. Sealant shall meet all SMACNA pressure classes up to 10" w.g. and SMACNA seal classes A, B and C.

- D. Apply sealant with brush working sealant into all joints. For spiral duct, apply sealant to male end of coupling prior to fitting straight run of duct to coupling. Follow manufacturer's instructions for all application requirements.
- E. The use of duct sealing tape of any kind is unacceptable.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

- A. Pipe systems shall be complete. Pipe shall be of size indicated or, where not indicated, shall be of size required to produce capacities of the equipment specified. No pipe shall be buried in floors, unless specifically indicated or approved.
- B. Install runs of piping as indicated. Cut pipe accurately to measurements established at the building by the Contractor and work into place without springing or forcing. Do not cut or move any structural portions of the building without approval. Run piping above ground, parallel with lines of buildings, unless otherwise shown or specified.
- C. Install piping to allow for expansion and contraction, using offsets, swing joints, expansion joints, anchors and related items as may be necessary. Make connections to coils, pumps and other equipment in such manner as to eliminate undue strains in piping and equipment and to prevent noise transmission. Provide necessary fittings and bends to avoid springing of pipes during assembly. Weld expansion loops using long-radius ells. Make changes in pipe sizes with reducing fittings.
- D. Pipe outlets of vent valves, safety valves, drip pans, overflow drains, condensate drains, backflow preventers and other drain points to floor drain unless otherwise indicated. Gages, thermometers and related items shall be carefully leveled. Thoroughly clean and flush piping in presence of the Engineer, as installed and before automatic vents are installed.
- E. Unless otherwise indicated, connections to equipment shall be as shown by manufacturer's data. Make piping connections to equipment with unions or flanged connections arranged so that equipment can be dismantled without disturbing the piping installation. Unions shall be accessible after building is complete. Provide valves to isolate equipment for service or removal.
- F. Close pipe openings with caps or plugs during installation. Cover fixtures and equipment tightly and protect against dirt, water and chemical or mechanical injury. Carefully free interior of pipe of superfluous material as work progresses. Upon completion of work, thoroughly clean fixtures, materials and equipment and deliver in approved unblemished condition.
- G. Lay pipe true to line and grade with bells up-grade so pipe will have smooth and uniform invert. Keep pipe thoroughly clean so jointing compounds will adhere. Inspect each pipe section for defects before lowering into trenches. Allow no water in trenches during pipe laying or around joints until compound has set.

- H. Ream pipe after cutting and before threading and remove burrs. Make screwed joints with graphite and oil or approved graphite compound applied to threads only. Cut threads full and not more than three threads on pipe shall remain exposed. Caulking of threaded joints to stop or prevent leaks will not be permitted. Provide unions where required for disconnection. Use swing joints for branch connections to risers and mains.
- I. Make copper tubing sweat joints with noncorrosive flux and lead-free solder recommended for service encountered or as indicated.
- J. No joint shall be made underwater. Secure watertightness and prevent damage or disturbing of joints during refilling process, or at other times after pipes have been laid and joints made. Do not walk or work over pipes except as necessary in tamping until at least 2" of covering has been placed over pipe. Uncover joints showing leaks; remake joint at Contractor's expense.
- K. The Contractor may, except at unions, weld pipe 2-1/2" and larger, using welding fittings. Welding material and labor shall be in accordance with an approved procedure conforming to ASME B31.9 Building Services code. Welders shall be fully qualified by an approved Welding Bureau or locally recognized testing authority. Welding shall be electric arc welding method. Welding of pipe inside the building shall not be permitted without approved ventilation. Galvanized pipe shall have the galvanizing ground from the heat affected zone.
- L. All copper pipe joints shall be made with fittings. Formed bell & spigot couplings and mechanical "T" formed joints are not acceptable.

3.2 TRENCH EXCAVATION AND BACKFILL

- A. Refer to Division 312000 "Earth Moving for Sitework" for excavating, trenching, and backfilling requirements.

3.3 EQUIPMENT INSTALLATION

- A. Erect equipment in neat and workmanlike manner. Align, level and adjust for satisfactory operation. Install so that connecting of piping and accessories can be made readily and so that parts are easily accessible for inspection, operation, maintenance and repair. Minor deviation from indicated arrangements may be made as approved by Architect.

3.4 EQUIPMENT SUPPORTS AND FOUNDATIONS

- A. Design and construct supporting structures of strength to safely withstand stresses to which they may be subjected and to distribute properly the load and impact over building areas. Conform to applicable technical societies' standards, also to codes and regulations of agencies having jurisdiction. Obtain approval before fabrication.
- B. Fasten wall-mounted or ceiling-hung equipment to building structures or inserts as approved.

- C. Provide adequate supports for roof-mounted mechanical equipment. Supports shall keep equipment clear of roof and transmit weight to roof structure as approved by Structural Engineer.
- D. The Contractor shall submit for review physical data for each unit supported from the building structure, either suspended from or attached to the building structure. The physical data shall include the equipment operating weight, corner weights, and center of gravity.

3.5 NOISE AND VIBRATION

- A. Mechanical and electrical equipment shall operate without objectionable noise or vibration as determined by the Owner.
- B. If such objectionable noise or vibration should be produced and transmitted to occupied portions of building by apparatus, piping, ducts, or other parts of mechanical and electrical work, make necessary changes and additions as approved, without extra cost to the Owner.
- C. Isolators shall prevent, as far as practicable, the transmission of vibration, noise, or hum to any part of building.
- D. Isolators shall suit vibration frequency to be absorbed. Provide isolator units of area and distribution to obtain proper resiliency under load and impact.

3.6 FLASHING

- A. Provide cap flashing for roof-mounted fans, goosenecks, air intakes, vents and the like.

3.7 PROTECTION OF EQUIPMENT AND MATERIALS

- A. Responsibility for care and protection of mechanical equipment rests with Contractor until Substantial Completion of the work.
- B. After delivery, before and after installation, protect equipment and materials against theft, injury, the environment, or damages from all causes.
- C. Protect plumbing fixtures and other equipment with enamel or glaze surfaces from damage by covering and/or coating as approved.
- D. Protect equipment outlets and pipe openings with temporary plugs or caps.
- E. During construction, seal off all openings into interior of equipment and ductwork with sheet metal or taped polyethylene sheathing to prevent infiltration of dust.
- F. Temporary MERV 8 filters shall be provided a minimum of every 14 days for all fans that are operated during construction and new MERV 13 filters shall be installed after all construction dirt has been removed from the building just prior to testing and balancing. Following the testing and balancing, MERV 13 filters shall be provided a

minimum of every 14 days for all fans that are operated during construction. Just prior to Final Completion, all filters shall be replaced with the final filters, with MERV ratings as indicated in the equipment schedules and specifications. Ducts shall be inspected for dust and dirt. Contractor shall provide a signed statement to indicate that new filters for each piece of equipment were installed just before Final Completion. Construction filters shall be removed and not be used as the final set of filters. The contractor shall keep a filter replacement log that includes equipment identifications and dates of filter installation. Log shall be provided to the Engineer and Owner for review on a monthly cycle. Should the Contractor fail to comply with the filter changes as specified, the Owner may, at his discretion, hire through a separate contract the specified filter changes and withhold the cost for this work from the construction contract amount as a back charge to the Contractor.

- G. Provide a spare filter (or sets of filters for equipment that require multiples) for each piece of equipment. Turn filters over to Owner with proper transmittal prior to Final Completion.
- H. Equipment not designed for exterior installation (i.e., cabinet unit heaters, wall heaters, unit heaters, exhaust fans, split systems, cassettes, fan powered VAV's, etc.) shall not be delivered to the job site until a location protected from the environment is provided. Location shall be approved by the Architect and Engineer prior to delivery.
- I. Equipment suitable for exterior installation (i.e., condensing units, packaged rooftop units etc.) shall not be delivered to the job site until it is ready to be installed in its permanent location.

**3.8 CONTRACTOR'S RESPONSIBILITY FOR MANUFACTURER'S AUTHORIZED
FIELD START-UP**

- A. The equipment manufacturer shall furnish a factory-trained and certified service technician without additional charge to start the HVAC equipment. This individual's certifications shall be submitted as a shop drawing along with the equipment and shall be reviewed and approved by the Engineer. Unit manufacturers shall maintain service capabilities no more than 100 miles from the job site.
- B. The HVAC equipment to be started by the manufacturer's certified technician shall include:
 - 1. Packaged rooftop air conditioning units
 - 2. Air handling units
 - 3. Split system air conditioning units
 - 4. 4-way Cassettes
- C. The manufacturer shall furnish complete submittal wiring diagrams of the HVAC equipment as applicable for field maintenance and service.
- D. Start-up sheets on all equipment shall be submitted and reviewed by the engineer. An approved copy shall be included in the final TAB report. If required, this same representative shall be made available to review the startup sheets onsite with the Engineer and Owner.

3.9 CONTRACTOR'S RESPONSIBILITY FOR TESTING, ADJUSTING AND BALANCING (TAB)

- A. Provide the TAB Agency a full set of Contract Documents (drawings and technical specifications), all manufacturers' approved submittal data and copies of revised data as soon as possible.
- B. Ensure that a current TAB Engineer's certification certificate is kept on file.
- C. Ensure all systems have been installed and are in 100% working order before the TAB Engineer is called to the job site, including but not limited to ductwork, piping, terminals, electrical and ATC. The Contractor shall verify that each item of the Pre-TAB Checklist (see Appendix A) has been completed and shall deliver a signed copy of the Pre-TAB Checklist to the Owner's Representative and the TAB Agency attesting that the project is complete and ready for TAB work to begin.
- D. Ensure that all ductwork requiring SMACNA – ADLTM duct leakage testing has been tested in the presence of the TAB Engineer and Owner's Representative and has met the referenced requirements.
- E. Provide adequate access to all points of measurement and adjustment and ensure that all dampers operate freely.
- F. Provide a factory representative for all major pieces of equipment as requested by the TAB Agency to assist in operation and performance verification of equipment.
- G. Cooperate with the TAB Agency to help operate and adjust the control systems directly related to TAB work and provide any specialties required to make such adjustments.
- H. Carefully review the drawings and Specifications for the various systems noting all facilities incorporated in the design for purposes of adjusting and balancing. Should it be deemed necessary to provide additional dampers, baffles, valves, or other devices which would aid in the required adjusting and balancing, same shall be provided by the installing contractor.

3.10 CLEANING, PAINTING AND IDENTIFICATION

- A. Remove from site excess material, equipment protection, etc. Thoroughly clean piping, hangers, equipment, fixtures and trimmings and leave every part in perfect condition ready for use, painting, or insulation as required.
- B. Paint exterior surfaces of equipment supports and other ferrous metal work, except that which is galvanized, with one coat of RUSTOLEUM damp-proof red primer, or approved equal.
- C. Finish painting of exposed piping, ductwork, equipment and insulation in finished spaces shall be done under Section 099900 "Painting".
- D. Refrigerant piping service shall be indicated with outdoor grade 3.2 mil thick high gloss adhesive backed vinyl labels which identify the service by name (not initials). Provide labels similar to Brimar, EZ Pipe Markers. Labels shall be used wherever piping is exposed, at all

unit connections and at 25-foot intervals for concealed piping located above accessible ceilings. Label and arrow heights shall be 1".

- E. All concealed condensate drain piping shall be labeled at its termination point with outdoor grade 3.2 mil thick high gloss adhesive backed vinyl labels which indicate whether the drain piping is connected to a primary or secondary (auxiliary) mechanical unit drain.
- F. Provide seals, signs and tags on fire protection equipment at designated locations per NFPA.
- G. Provide color-coded identification dots affixed to the ceiling grid for equipment, access doors, terminal equipment controllers, smoke detectors, filters and valves concealed above ceilings. Provide a color-coded chart identifying type of equipment or valve. Chart shall be framed and mounted, under clear plastic and located as directed by Owner.

3.11 EQUIPMENT MARKING

- A. Label all mechanical equipment, including starters, control panels, fans, VAV boxes, package rooftop units, temperature sensors, humidity sensors, and CO2 sensors.
- B. Labels on panels and equipment shall be machine engraved, laminated, 1/8" thick, Bakelite, nameplate type.
- C. Labels shall have 1/4" high letters.
- D. Labels shall be rigidly attached using rivets or screws. Adhesive backing is not acceptable.
- E. Sensor labels shall be a self-adhesive type label. Labels shall identify the equipment served by the sensor.

3.12 EQUIPMENT INVENTORY

- A. Provide a complete equipment inventory for all Mechanical, Plumbing and Fire Protection equipment included in the project scope of work. Refer to Appendix B of this section for the required template. A separate form shall be provided for each new piece of equipment provided.
- B. Prior to substantial completion, submit the equipment inventory forms for review. Once approved, include the forms in the operation and maintenance manual.

APPENDIX A

PRE-TAB CHECKLIST

A. GENERAL

1. All components of the HVAC system have been installed, including controls and control wiring.
2. Power wiring has been installed and energized to all motorized equipment. Also, all line voltage control wiring required has been installed.
3. All equipment has been started and run tested through all specified sequences of operation by factory-authorized representatives and all safety controls have been verified to be operational.
4. All required testing of piping and duct systems has been completed in accordance with the drawings and specifications.
5. Duct leakage testing, where required, shall be witnessed by the Owner's Representative and/or the TAB Agency.

B. HVAC WATER DISTRIBUTION SYSTEMS

1. Piping systems have been flushed thoroughly, strainers have been removed, cleaned and replaced as required. There is no evidence of plugged piping, coils, heat transfer equipment, valves, or flow measuring devices.
2. All air has been vented from the hydronic piping systems, equipment and coils.
3. All control valves are installed and functioning properly according to the specified sequences of operation.
4. All required pressure, temperature and flow measuring devices and balancing valves have been installed. All taps and adjustment dials are accessible and adequate clearances have been provided for connection of instrument hoses and adjustment taps, dials and scales are free of paint, insulation mastic and other foreign matter.

C. AIR DISTRIBUTION AND VENTILATION SYSTEMS

1. All air system filters have been replaced with new filters. The air moving equipment, ductwork and air terminals are installed and connected. All air systems are unobstructed and free of debris.
2. All manual volume control dampers required are installed and properly connected to adjustment handles. All damper handles are accessible and not covered by insulation or draw bands. All automatic dampers required have been installed with linkages connected and adjusted to provide the specified sequence of operation.
3. Access doors have been installed where required to allow inspection and servicing of duct-mounted dampers, equipment and components.
4. All ductwork and connections of duct to air terminals have been checked and no visible or audible leakage exists.
5. Fans are rotating in correct direction. Fans have been lubricated. Drive pulleys are aligned and belt tension is correct. Setscrews are tight securing keys into key-ways. Fan wheels turn freely and are balanced. Belt guards are in place.
6. Vibration isolators and flexible connectors have been installed where required. With fans in operation, there is no excessive vibration of fan assemblies or ductwork.

I, _____ an authorized representative of
(Signature and Title)

(Company)

attest that all items contained in the above Pre-Tab Checklist have been completed

and verified as of this date: _____.

APPENDIX B

Equipment Inventory Template

Project Name: (Add Project Name)

Project Address: (Add Project Address)

Description of Item: _____
(i.e., Air Handling Unit, Ductless Split System, etc.)

Classification:

- ☐ HVAC
☐ Plumbing
☐ Fire Protection

Building: _____

Equipment Location (Room Number): _____

Date Purchased: _____

Date Placed in Service: _____

Original Cost: _____

Life Expectancy (Years): _____

Estimated Replacement Date: _____

Estimated Replacement Cost: _____

Manufacturer: _____

Model/Serial #: _____

END OF SECTION 230100

SECTION 230500 - HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and Section 230100 "Mechanical General Provisions" apply to this Section.
- B. Refer to Specification Sections 230900 "Automatic Temperature Controls" and the Control Diagrams on the Contract Drawings for additional requirements and coordination between equipment and controls.
- C. **Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.**

1.2 WARRANTY-GUARANTEE

- A. Contractor shall furnish written warranty, countersigned and guaranteed by the General Contractor, stating that work executed under this Section of the Specifications shall be free from defects of material and workmanship for a period of 12 months from date of Substantial Completion of the building. Refer to Section 230100 for additional warranty period responsibilities.

1.3 SUBMITTALS

- A. Prior to fabrication of any ductwork, Mechanical Contractor shall prepare and submit for review and approval 1/4" scale ductwork shop drawings. Drawings shall indicate all equipment locations and double line ductwork layout. Drawings shall be coordinated with existing conditions and Architectural, Structural, Sprinkler and Electrical Drawings.
- B. Submit manufacturer's performance data and unit details on all products specified below or indicated on Contract Drawings.

1.4 PROTECTION OF EQUIPMENT AND MATERIAL

- A. All equipment and material not specifically designed for exterior installation shall not be delivered to the job site until an indoor, dry location is available for storage. All equipment and material shall be covered and protected from dirt, debris, moisture, paint, coatings, and damage of any kind. Store off the floor, in a location approved by the Owner, to prevent contact with water.

PART 2 - PRODUCTS

2.1 HEAT GENERATION (NOT USED)

2.2 REFRIGERATION (NOT USED)

2.3 AIR HANDLING EQUIPMENT

A. Exhaust Fans:

1. Fans shall be size, type, and have capacity as indicated on drawings. GREENHECK, LOREN COOK, ACME, or approved equal.
2. Fans shall be licensed to bear the AMCA Air and Sound Certified Ratings Seal. Fan air performance ratings shall be based on tests conducted in an AMCA registered laboratory for AMCA 210 air performance testing. The Test Standard used shall be ANSI/AMCA Standard 210-85, ANSI/ASHRAE Standard 51-1985, "Laboratory Methods of Testing Fans for Rating." All sizes must be tested, calculations to other sizes not acceptable. Fan sound performance shall be based on tests conducted in an AMCA registered laboratory for AMCA 300 Sound Performance Testing. The Test Standard used shall be AMCA 300 "Reverberant Room Method for Sound Testing of Fans." All sizes must be tested, calculations to other sizes are not acceptable. Air or Sound Test results are to be included in submittal.

a. Ceiling and Cabinet Exhaust Fans:

- 1) Ceiling and Cabinet fans shall be constructed of galvanized steel, with forward curved direct-drive centrifugal fans. Provide factory-wired plug-type disconnect and gravity back-draft damper. Provide aluminum ceiling grille for ceiling fans.

b. Inline Exhaust Fans:

- 1) Cabinet in-line type shall have backward-inclined aluminum centrifugal fan wheel, gravity counterbalanced back-draft dampers, galvanized fan housing and factory-wired disconnect switch. Provide vibration isolators as specified elsewhere in this section.
3. Provide solid state speed control for direct drive fans, where scheduled.
4. Provide electronically commutated motors for direct drive fans where scheduled.
5. Provide line voltage thermostat where scheduled.
6. All fans shall be statically and dynamically balanced.
7. Install as required for quiet operation.

B. Packaged Air Conditioning Unit (RTU-1, RTU-2 & RTU-3) (Owner Furnished, Contractor Installed)

1. Packaged air conditioning units shall be accordance with the following specifications and capacities as shown on the plans. Provide unit manufactured by TRANE Model HORIZON. NO SUBSTITUTIONS.
2. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, exhaust fans, dampers, air-cooled condenser coils, condenser fans, reheat coil (RTU-2 & RTU-3 ONLY), gas heaters, and unit controls.
3. Unit shall be specifically designed for outdoor applications and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-454B refrigerant and oil.
4. Unit shall be factory run tested prior to shipment. Factory test shall include refrigeration circuit run test, unit control system operations checkout, refrigerant leak test and final unit inspection.
5. Unit components shall be labeled, including refrigeration system components and electrical and controls components.
6. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
7. Installation, Operation, and Maintenance manual shall be supplied within the unit.
8. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
9. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.
10. General:
 - a. The supply and return openings shall be vertical or horizontal airflow (refer to drawings for location). Cooling performance shall be rated in accordance with ETL testing procedures. All units shall be factory assembled, internally wired, fully charged with R-454B, and 100 percent run tested to check cooling operation, fan and blower rotation, and control sequence before leaving the factory. Wiring internal to the unit shall be colored and numbered for simplified identification. Units shall be ETL listed and labeled, classified in accordance with UL 1995/CAN/CSA No. 236-M40 for Central Cooling Air Conditioners.
 - b. Casing
 - 1) Unit casing shall be constructed of zinc-coated, heavy gauge, galvanized steel. Exterior surfaces shall be cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Unit's surface shall be tested at a minimum of 672 hours in a salt spray test in compliance with ASTM B117. Unit shall have a 2-inch thick Antimicrobial Insulation. All insulation edges shall be either captured or sealed. The unit's base pan shall have no penetrations within the perimeter of the curb other than the raised downflow supply/return openings to provide an added water integrity precaution, if the condensate drain backs up. The top cover shall be one piece construction or, where seams exist, it shall be double-hemmed and gasket-sealed. The ribbed top adds extra strength and enhances water removal from unit top.
 - c. Drain Pan

- 1) The drain pan shall be a single-walled assembly made of Type 304 stainless steel. It shall be sloped in two planes and is fully drainable. The coils shall be mounted above the drain pan to allow easy inspection and cleaning of the drain pan.
- d. Supply and Exhaust Fans and Motors
 - 1) Fan motor shall be direct drive type with factory installed Variable Frequency Drive. All motors shall be thermally protected. All indoor fan motors meet the U.S. Energy Policy Act of 2005 (EPACT). Fan shall be a high efficiency backward curved impeller.
- e. Condenser Fan
 - 1) Condenser fans shall be controlled via VFD to maintain adjustable pressure to increase reheat capacity where applicable and low ambient control.
 - 2) Provide with condenser hail guards.
- f. Dampers – Low Leak
 - 1) The outside air damper shall have a unit-controlled actuator with parallel-blades. The blade construction shall be 14-gage galvanized steel, roll-formed airfoil-type.
- g. Return Air
 - 1) Dampers shall be low-leak. Each damper shall have a unit-controlled actuator. Inputs shall be provided for unoccupied economizer control, based upon a comparison of the outside air stream to a dry bulb reference point an information-only diagnostic message on the human interface and will allow continued unit operation.
- h. Filters
 - 1) 2-inch MERV-13 filters shall be installed just upstream of the evaporator coil. In addition, 2-inch aluminum mesh mist eliminators shall be located in the intake hood.
 - 2) A Filter Status switch shall indicate when filters require cleaning or replacement.
- i. Sensors
 - 1) A factory installed combination outdoor air sensor located in the outdoor air hood is designed to sense both outdoor air temperature and relative humidity for use by the microprocessor controller to make required ventilation, cooling, dehumidification and heating decisions.

j. Compressors

- 1) Unit shall have direct-drive, hermetic, digital scroll type compressors with centrifugal type oil pumps. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage. Internal overloads shall be provided with the scroll compressors. Crankcase heaters shall be included. Compressor shall be able to fully modulate from 20 percent to 100 percent.

k. Evaporator and Condensing Coils

- 1) Internally finned copper tubes mechanically bonded to a configured aluminum plate fin shall be standard. Coils shall be leak tested at the factory to ensure the pressure integrity. The evaporator coil and condenser coil shall be leak tested to 500 psig and pressure tested to 500 psig. The condenser coil shall have a fin design with slight gaps for ease of cleaning. Evaporator coil will have six interlaced rows for superior sensible and latent cooling.

l. Gas Heat: Modulating

- 1) Primary heat is supplied using indirect fired gas heating. The heating section shall have a progressive tubular heat exchanger using Stainless Steel burners and type 439 Stainless Steel tubes. An induced draft combustion blower shall be used to pull the combustion products through the firing tubes. The heater shall use a direct spark ignition (DS) system.

m. Controls

- 1) Unit is completely factory-wired with necessary controls and contactor pressure lugs for power wiring. Units have a Multi Zone VAV control device with a display. Microprocessor controls are provided for all 24-volt control functions. The resident control algorithms will make all heating, cooling and/or ventilating decisions in response to electronic signals from sensors measuring outdoor temperature and humidity. The control algorithm maintains accurate temperature control, minimizes drift from set point, and provides better building comfort. A centralized micro-processor (UC600) will provide anti-short cycle timing for a higher level of machine protection. Terminals are provided for a field installed dry contact or switch closure to put the unit in the Occupied or Unoccupied modes. A factory provided static pressure sensor will be shipped with the unit for installation inside the supply ductwork.

- n. Short Circuit Withstand Rating of the unit electrical enclosure shall be 65,000 Amps. Rating shall be published in accordance with UL508.
- o. Roof Curbs
 - 1) Provide factory supplied roof curb, heavy gauge zinc coated steel with supply and return air gasketing. Ship knocked down, and provide instructions for easy assembly.
 - 2) Curb shall be manufactured in accordance with the National Roofing Contractors Association guidelines for rooftop equipment support.
- p. Warranty
 - 1) Refer to Specification section 230100 for additional warranty information.

2.4 UNITARY EQUIPMENT

A. Split System Units (IU-1 Through IU-5) (Owner Furnished, Contractor Installed):

- 1. Quality Assurance:
 - a. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.
 - b. All wiring shall be in accordance with the National Electrical Code (NEC).
 - c. The units shall be rated in accordance with Air-conditioning, Heating, and Refrigeration Institute's (AHRI) Standard 240 and bear the ARI Certification label.
 - d. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
 - e. A dry air holding charge shall be provided in the indoor section.
 - f. The outdoor unit shall be pre-charged with R-454B refrigerant for up to 100 feet line length of refrigerant tubing.
- 2. Delivery, Storage and Handling:
 - a. Unit shall be stored and handled according to the manufacturer's recommendations.
- 3. Warranty:
 - a. The units shall have a manufacturer's defects warranty for a period one (1) year from date of installation. Parts shall have a warranty of 5 years from the date of installation. The compressor shall have a warranty of 7 years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty does not include labor.

- b. Manufacturer shall have over 25 years of continuous experience in the U.S. Market.
- 4. Indoor Unit (IU-1):
 - a. The indoor unit cabinet shall be wall mounted by means of a factory supplied mounting plate. The cabinet shall be formed from high strength molded plastic with front panel access for filter. Cabinet color shall be pure white.
 - b. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor.
 - c. The unit in conjunction with the wired, wall-mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory.
 - d. Fan: The fan shall be direct drive fan with a single motor. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.
- 5. Indoor Concealed Ceiling Mounted Unit (IU-2):
 - a. The indoor unit cabinet shall be concealed ceiling type. The cabinet shall be formed from galvanized steel with closed-cell internal insulation.
 - b. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and piping, control circuit board and fan motor.
 - c. The unit in conjunction with the wired, wall-mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory.
 - d. Fan: The fan shall be direct drive fan with a single motor. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperatures.
- 6. Indoor Ceiling Mounted Unit (IU-3 through IU-5):
 - a. The indoor unit cabinet shall be a space-saving ceiling-recessed cassette type. The cabinet shall be formed from galvanized sheet metal covered by plastic with architectural finish suitable for exposed surfaces.
 - b. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, drain left mechanism, control circuit board, fan, and fan motor. Single branch ducting shall be allowed from cabinet. The cabinet panel shall have provisions for a field installed filtered outside air intake.
 - c. A separate grill assembly shall be attached to the front of the cabinet to provide supply air vanes in four directions and a center mounted return air section. The four-way grill shall be fixed to bottom of cabinet allowing two, three or four-way blow. The grill vane angles shall be individually adjustable from the wired

- remote controller to customize the airflow pattern for the conditioned space.
 - d. The unit, in conjunction with the wired, wall-mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and integral refrigerant pipes shall be purged with dry nitrogen and capped before shipment from the factory.
 - e. Fan: The fan shall be direct drive fan with a single motor. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperatures.
- 7. Filter: The return air shall be filtered by means of an easily removable, long life, washable filter.
- 8. Coil:
 - a. The indoor unit coil shall be of nonferrous construction with pre-coated aluminum fins on copper tubing with closed-cell insulation.
 - b. The heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed with PhosCopper or silver alloy.
 - c. The coils shall be pressure tested at the factory.
 - d. A non-ferrous material condensate drain pan with drain connections shall be provided under the coil. The unit shall also include a built-in, automatic condensate lift mechanism that will be able to raise drain water to an elevation above the top of cabinet. The lift mechanism shall be equipped with a positive acting liquid level sensor to shut down the indoor unit if liquid level in the drain pan reaches maximum level.
- 9. Electrical:
 - a. The electrical power of the unit shall be 208/230 volts, 1-phase, 60 hertz.
 - b. The system shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts.
 - c. The indoor unit shall be provided with A-Control – a system allowing the indoor unit to be powered and controlled directly from the outdoor unit using a 14-gauge (AWG) 3-wire connection plus ground providing both primary power and integrated, bi-directional, digital control signal without additional connections.
- 10. Control:
 - a. The control system shall consist of two (2) microprocessors, one in each indoor and outdoor unit, interconnected by A-Control. This three (3) conductor 14 ga. AWG wire with ground method shall provide power feed and bi-directional digital control transmission between the outdoor and indoor units.
 - b. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller display panel.

- c. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and for controlling the operation of the outdoor unit.
- d. The indoor unit shall be connected to a wall mounted wired controller to perform input functions necessary to operate the system. The wired controller shall have a large multi-language DOT liquid crystal display (LCD) presenting contents in eight (8) different languages, including English, French, Chinese, German, Japanese, Spanish, Russian, and Italian.
- e. There shall be a built-in weekly timer with up to eight pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Heat/Auto/Cool/Dry/Fan mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Vane Position selector, a Louver Swing button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C). Temperature changes shall be by increments of 1°F (1°C) with a range of 67°F to 87°F (19°C to 30°C).
- f. Normal operation of the wired controller shall provide individual system control in which one wired controller and one indoor unit are installed in the same room. Temperature sensing shall be done by a Thermistor mounted in the return air stream of the indoor unit. An alternate temperature sensor shall be located within the wall controller. Selection of the sensor is by switch in the indoor unit. The controller shall have the capability of controlling up to a maximum of sixteen systems at a maximum developed control cable distance of 1,650 feet (500 meters).
- g. The control voltage from the wired controller to the indoor unit shall be a digital +/-24 volts, DC signal. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Up to two wired controllers shall be able to be used to control one unit.
- h. Control system shall control the continued operation of the air sweep louvers, as well as provide On/Off and mode switching. The controller shall have the capability to provide sequential starting with up to fifty seconds delay.

11. Outdoor Unit (OU-1 through OU-3):

- a. The outdoor unit shall be compatible with PUY, PUZ and MXZ type indoor units. The connected indoor unit must be of the same capacity as the outdoor unit.
- b. The outdoor unit shall be equipped with a control board that interfaces with the indoor unit to perform all necessary operation functions.
- c. The outdoor unit shall be capable of operating at 0°F ambient temperature without additional low ambient controls (optional wind baffle may be required).
- d. The system shall have a maximum refrigerant tubing length of 165 feet for the 18,000 and 225 feet for the 36,000 BTU/h units between indoor and outdoor units without the need for line size changes, traps or additional oil.
- e. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory.

- f. Cabinet: The casing shall be constructed from galvanized steel plate, coated with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection.
- g. Fan: Fans shall be furnished with Brushless DC or electronically commutated fan motor. The fan motor shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated. The outdoor unit shall have horizontal discharge airflow.
- h. The compressor shall be a DC rotary compressor with Variable Compressor Speed Inverter Technology. The compressor shall be driven by an inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which results in vast energy savings. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be intermittently applied to the compressor motor to maintain sufficient heat. The outdoor unit shall have an accumulator and high-pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

2.5 TERMINAL EQUIPMENT

A. Electric Cabinet Unit Heater (Owner Furnished, Contractor Installed):

- 1. Units shall be size, type, and have capacity as indicated. Provide units manufactured by MARKEL, or approved equal.
- 2. Cabinet: The cabinet shall be constructed of heavy-duty 16-gauge zinc-coated steel. The cabinet shall be finished with a durable powder coated beige paint. The front cover shall be removable for easy installation and service of all internal components. The grille configuration shall be convertible to any airflow configuration by removal of four fasteners. The cabinet shall be designed for floor, wall, or ceiling mounting.
- 3. Elements: Elements shall be all steel tubes with highest quality nickel-chromium resistance wire embedded in compacted efficient dielectric to ensure proper heat transfer. Steel helical fins shall be machine crimped and brazed to tube for effective transfer of heat.
- 4. Motor and Blower Assembly: Motor and blower shall be direct drive and resiliently mounted on a rigid heavy-gauge steel frame for quiet operation and long life. All motors shall have built-in overload protection and shall be lifetime lubricated. The motor shall be vented and mounted in the airstream to provide maximum cooling of the motor.
- 5. Limit Controls: The heater shall utilize two safety limits built into the controls to automatically shut off the heater if safe operating temperatures are exceeded. The primary limit shall be a capillary type, which senses the heat along the full length of the elements. The secondary limit shall be a manual reset thermal device. All heaters shall have a built-in fan purge to dissipate residual heat from elements on heater shutdown.
- 6. Controls: Heater shall have high/low heat and fan rocker switch. These controls shall be factory wired and tamper resistant and adjustable through front of louver assembly.

B. Unit Heaters (Owner Furnished, Contractor Installed):

1. Units shall be size, type, and have capacity as indicated provided by MARKEL, TRANE CO., Q-MARK or approved equal.
2. Units shall be complete, including casing, electric as indicated, fan, fan guard, and motor. Units shall be horizontal discharge type with adjustable air deflectors.
3. Temperature Controls: Refer to Section 230900 "Automatic Temperature Controls."

C. Electric Wall Heaters (Owner Furnished, Contractor Installed):

1. Units shall be size, type, and have capacity as indicated provided by MARKEL, TRANE CO., Q-MARK or approved equal.
2. Units shall be complete, including casing, 16-gauge steel bar grille, electric heating coil, fan, and permanently lubricated motor. Provide with built-in and factory-wired disconnect switch and integral thermostat.
3. Color of enclosure shall be selected by the Architect.

D. Electric Barrier Heaters (Owner Furnished, Contractor Installed):

1. Units shall be size, type, and have capacity as indicated provided by MARKEL, TRANE CO., Q-MARK or approved equal.
2. Units shall be complete, including casing, 16-gauge steel front with 18-gauge back, 1/4" pencil proof discharge louvers, multiple electric heaters factory wired on same back plate, pedestals and line voltage line thermostat. Provide with built-in and factory-wired disconnect switch.
3. Color of enclosure shall be selected by the Architect.

2.6 HVAC PIPING AND SPECIALTIES

A. Piping

1. Water, refrigerant, and HVAC drain piping shall be provided as specified below. Where options of different materials are given for the same service, contractor shall select materials and use them uniformly throughout the system. Contractor shall submit experience with all of the materials and joining methods specified.
2. Hot water piping:
 - a. Above ground
 - 1) Type L copper (2" and under)
3. Condensate drain piping
 - a. Above ground (within building and plenum rated ceiling)
 - 1) Type L copper
 - b. On rooftop and exterior to building

- 1) Schedule 40 PVC
- c. Below ground: Refer to Specification Section 220500 "Plumbing."
4. Refrigerant Piping:
 - a. Above ground
 - 1) Copper type ACR
5. Type L copper pipe shall conform to ASTM B42 and be assembled with wrought-copper soldering fittings using 95-5 solder or with press fittings as specified herein.
6. Schedule 40 PVC pipe shall be assembled in strict accordance with manufacturer's instructions. Solvent cement shall conform to ASTM D2564.
7. Schedule 40 black steel pipe shall be fabricated by threaded fittings.
8. Press Fittings
 - a. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and NSF/ANSI Standard (NSF 61). Sealing elements for press fittings shall be factory installed EPDM.
 - b. Press fittings 1/2" – 2" press end shall have a leak-before-press feature, which assures leakage from inside the system past the sealing element of an unpressed connection. Fittings 2-1/2" – 4" press end shall have a factory installed means for visual inspection of completed press.
 - c. Copper press fitting joints shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tuning marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark in the tubing to ensure the tubing is fully inserted in the fitting. The joints shall be pressed using the pressing tool and jaws or jaw set, approved by the fitting manufacturer.
 - d. Fitting installer shall be trained by the fitting manufacturer's factory representative.
 - e. Press connected fittings shall be by VIEGA "ProPress," NIBCO "Press System," AALBERTS "Apollo Press," or equal.
9. ACR tubing shall be nitrogen-filled assembled with wrought-copper soldering fittings using silver solder.
10. Piping shall be run concealed, except where no ceiling is provided. Coordinate installation of piping with other disciplines. Locate all piping tight against structure where possible. No piping shall be installed below mechanical equipment, or within mechanical or electrical equipment clearance requirements.
11. All concealed condensate drain piping shall be labeled at its termination point to indicate whether the drain piping is connected to a primary or secondary (auxiliary) mechanical unit drain.

B. Valves:

1. Valves 2" size and under shall be bronze with soldered ends, rough bodies, and finish trim. Valves 2-1/2" size and over shall be iron-body, bronze-mounted with flanged ends, except where specifically indicated. Catalog numbers indicated below are

NIBCO. Valves with equivalent characteristics by APOLLO, or MILWAUKEE are acceptable.

| Size | Pipe Material | Check | Ball/Butterfly |
|--------------|---------------|---------|----------------|
| 2" and under | Copper | S-413-W | S-585-70-66NS |

- Balancing valves 2" and smaller shall be NIBCO "S-585-70-66NS". Valves shall be complete with memory stops. Acceptable alternate valves include MILWAUKEE "BA-150S-MS," or APOLLO "70-200-27."

C. Automatic Balancing Valves

- Provide automatic measuring and balancing valves where indicated for pipe sizes 1/2" to 2". Valves shall be NUTECH "AB," IMI "AC," or CALEFFI "Series 121" for valves 1/2" through 2".
- The GPM for the automatic flow control valves shall be factory set and shall automatically limit the rate of flow to within 5% of the specified amount.
- For 1/2" - 2", the flow cartridge shall be removable from the Y-body housing without the use of special tools to provide access for cartridge change out, inspection, and cleaning without breaking the main piping. (Access shall be like that provided for removal of a Y-strainer screen).
- True operating range of 2 - 32 psid required. The design flow should be achieved at the minimum psi differential. A 50% safety factor applied to the lower operating range is not acceptable.
- Each valve shall have two P/T ports.
- All automatic flow control devices shall be supplied by a single source.
- Five-year product warranty and free first year cartridge exchange.
- The internal wear surfaces of the valve cartridge shall be Ultrason composite or stainless steel.
- The flow cartridge design shall incorporate a stainless-steel spring which requires no adjustment screw or shims. A crimped sheet-metal design is not acceptable.
- The internal flow cartridge shall be permanently marked with the GPM.
- All valves shall be factory leak tested at 100 psi air underwater.
- Ratings: 1/2" through 2" pipe size: 600 psig at 250°F
2-1/2" through 12" pipe size: 600 psig at 250°F
- Where indicated on the plans, the differential pressure across the automatic flow control valve shall be measured for flow verification and to determine the amount of system over-heading or under-pumping. Where over-heading exists the ball valve shall be throttled to bring the flow cartridge back within the control range. The valve memory stop shall be set so the valve can be used for isolation and reopened to the balanced position.
- The flow shall be verified by measuring the differential pressure across the coil served or the wide-open temperature control valve and calculating the flow using the coil or valve C_v.
- Install automatic flow control valves on the return lines of coils as indicated on the plans. Balancing valve on supply side is not acceptable. Submit proposed piping arrangement for approval by the Engineer.
- The standard ports and handles shall clear 1" thick insulation. Handle and port extensions are required for over 1" thick insulation.

17. Install, on the supply side of coils, a Y-strainer with a brass blow-down valve with 3/4" hose end connection with cap and chain.

2.7 AIR DISTRIBUTION

A. Ductwork:

1. Provide all ducts, plenums, connections, dampers, and related items required to form a complete system as indicated on drawings and specified herein.
2. All ductwork shall be constructed of sheet metal unless otherwise indicated.
3. Sheet-metal ducts shall be fabricated from G90 galvanized-steel sheets, and shall be of gauges called for and as detailed in 2020 SMACNA Manual, HVAC Duct Construction Standards (Metal and Flexible). All ductwork pressure class construction shall be as indicated on the drawings and shall be single wall rectangular or single wall round,. Rectangular ductwork shall be single-wall construction unless otherwise indicated except ductwork exterior to the building shall be double wall with 3" insulation encapsulated between inner and outer sheet metal shells.
4. Duct sealing requirements shall be as indicated on the drawings.
5. Aluminum ductwork shall be used for dishwasher exhaust ductwork. Duct shall be sealed watertight. Duct shall be sloped down to grilles. Stainless-steel ductwork shall be used for all dishwasher exhaust ductwork. All seams on exposed stainless-steel ductwork shall be polished.
6. Round duct and fittings shall be manufactured by a company for whom the manufacture of spiral duct and welded fittings has been a principal business for at least 15 years. Contractor fabricated round spiral duct and fittings shall not be acceptable.
7. All companies being considered as potential suppliers of duct and fitting components shall submit drawings and dimension data for approval. These submittals shall serve as a basis for acceptance or rejection of products.
 - a. All fittings furnished for use on a project shall be identical to the approved submittal data.
 - b. Any fittings rejected by the project engineer shall be replaced with fittings equal to the original approved submittals. All expenses incurred in the replacement of fittings that do not conform to these requirements shall be the responsibility of the installing contractor.
8. All medium and high pressure supply duct shall be of round spiral lock seam construction where indicated. Steel round duct shall be of standard spiral with 2C corrugations for all duct greater than 14" diameter (without intermediate ribs) or single-rib construction and shall be provided with gauges according to the following 2020 SMACNA HVAC DCS, except no 28-gauge material is allowed:

| Diameter (inches) | Standard Spiral Gauge | | Single-Rib Spiral Gauge 0-10" w.g. |
|----------------------|-----------------------|------------|---------------------------------------|
| | 0-2" w.g. | 2-10" w.g. | |
| 3-8 | 28 | 26 | -- |
| 9-14 | 28 | 26 | 28 |
| 15-26 | 26 | 24 | 28 |
| 27-36 | 24 | 22 | 28 |
| 37-42 | 22 | 20 | 28 |

9. Duct shall be provided in continuous, un-joined lengths wherever possible. Except when interrupted by fittings, round spiral duct sections shall not be less than 12 feet long. Round spiral pipe and fittings greater than 24" diameter shall have flanged connections. All double-wall rectangular ductwork shall have flanged connections. Flanges for double-wall duct shall also hold the inner liner of dual wall duct concentric without the use of additional couplings or spacers.
10. Unless otherwise specified, all rectangular double-wall duct and fittings shall be a minimum G90 galvanized sheet metal.

| Nominal Duct Size | Inner/Outer Shell (Gauge) | Inner Shell (Gauge) |
|-------------------|------------------------------|------------------------|
| 3-24 | 26 | 26 |
| 25-34 | 24 | 26 |
| 35-42 | 22 | 26 |

11. Fittings for double-wall duct shall be of the following minimum gauges:

| Nominal Duct Size | Inner/Outer Shell (Gauge) | Inner Shell (Gauge) |
|-------------------|------------------------------|------------------------|
| 3-34 | 22 | 24 |
| 35-48 | 20 | 22 |

12. Round fittings may be spot welded and bonded.
13. Insulation shall have the following UL rating:
 - a. Flame Spread: 10-20
 - b. Fuel Contributed: 10-15
 - c. Smoke Developed: 0-20
14. Round ductwork shall not be delivered to the job site until just prior to erection. Ductwork with dents or other damage shall not be accepted. Double-wall ductwork shall be removed from the job site and shall not be used if insulation is allowed to become wet to any degree.
15. Rectangular ductwork shall be constructed from galvanized steel sheets of lock form quality per ASTM A653 with a G90 zinc coating (0.60 oz/ft²), unless otherwise shown on the contract documents. Sheets shall be free of pits, blisters, slivers, and ungalvanized spots.
16. Insulated-flexible acoustical air ducts shall be FLEXMASTER USA "1M," THERMAFLEX "M-KE," or equal, suitable for up to 10" w.g. positive pressure and rated velocity of 5500 FPM. Flexible ductwork shall meet NFPA 90A standards, conform to UL standard 181, and be ETL listed Class 1 air duct. Flexible duct shall have a flame spread of less than 25 and smoke developed of less than 50. Flexible ductwork shall be fabricated with a polyethylene or chlorinated polyethylene inner film, wrapped in 2" thick with a thermal conductance of R-6 fiberglass insulation, with an outer reinforced metallized vapor barrier. The inner film shall be supported by a corrosion resistant galvanized steel helix formed and mechanically locked to the polyethylene fabric. The inside bend radius shall be 1/2 x inside diameter in all sizes. Flexible branch ductwork to diffusers shall be limited to maximum length of 5 feet

long and maximum velocity of 600 feet per minute. Contractor to provide proper flex duct size to ensure velocity limit is not exceeded. Support flexible ducts a minimum of every 4 feet. Supports shall not compress or constrict the flexible duct. Refer to the diffuser installation details on the drawings.

17. Provide flexible connections of fiberglass between ducts and air-handling unit connections, fan powered VAV boxes, and exhaust fans. Connector shall be constructed using double lock gripping fingers at metal to fabric contact. Connector shall be rated airtight and watertight up to 10" w.g. positive to 10" w.g. negative pressure. Provide flexible connections, not less than 4 inches wide, constructed of approved fireproof, waterproof, non-asbestos, glass fabric, at the inlet and outlet connection of each fan unit, securely fastened to the unit and to the ductwork by a 24-gauge galvanized steel band provided with tightening screws. Insulation on flexible connections shall be stretched over the metal band and taped to the inlet and outlet connections of the VAV terminal unit. There shall be no metal-to-metal contact at flexible connections. There shall be no stretching of the flexible material at flexible connections. Flexible duct connections at variable air volume terminals shall be a maximum of 3 feet long. The connection shall be UL listed, to meet NFPA 90A and 90B requirements and the following applications:
 - a. Indoor: Neoprene coated glass fabric, minimum 30 oz./sq.yd.
 - b. Outdoor: U.V. resistant Hypalon coated glass fabric, minimum 24 oz./sq.yd.
 - c. Flexible connections shall be DUCTMATE "ProFlex," DURODYNE "Flexible Duct Connector," KINETICS "KINFLEX," or equal.
18. Space suspended duct hangers and roof mounted duct supports every 4 feet, maximum. Insulated duct shall have saddle hangers. Suspended duct hangers attached to the side of the ductwork are acceptable. Refer to duct support details on the drawings.
19. Fabricate ductwork with airtight joints, presenting smooth surface on inside, neatly finished on outside. Unless otherwise indicated, provide square or rectangular elbows and provide double wall turning vanes in all elbows. Deflecting vanes shall be double wall blades, fit into side rails, and screw or rivet to duct elbow in field. Blades and side strips shall be small or large double vanes as detailed in SMACNA Duct Manual. Turning vanes shall be DUCTMATE "ProRail," AERODYNE "H-E-P Turning Vanes," DURODYNE "Vane and Rail" or equal.
20. Construct, brace, and support ducts and air chambers in a manner that they will neither sag nor vibrate to any perceptible extent when fans are operating at maximum speed or capacity.
21. Provide sandwich type or square framed access doors for service temperature and pressure required, where indicated and where not indicated, in locations and of sizes which shall afford easy access to multi-blade dampers, smoke detectors, fire dampers, and other equipment and devices requiring inspection and servicing. Access doors shall be installed to avoid lights, piping, conduit, ceiling grid, etc., to provide unobstructed access. Access doors shall be installed on the underside of the ductwork. Access doors shall be a minimum of 24" x 18" where possible. Access doors in all factory fabricated ductwork shall be factory installed and sizes and locations shall be identified on the ductwork shop drawing submittal. Duct access doors shall be DUCTMATE "Sandwich Access Door," GREENHECK "CAD-10," ACUDOR "CD-5080," or equal.

22. Connect ductwork to intake and discharge louvers, dampers, and other work installed in various trades requiring sheet-metal connections.
23. Make sheet-metal connections to masonry work airtight and watertight in approved manner.
24. Provide opposed-blade dampers for control of air volume and for balancing system, where indicated or required. Dampers shall be of sheet metal at least one gauge heavier than duct and reinforced; shall be installed in an accessible location. Provide indicating quadrant and locking device for adjusting and locking dampers in position. Provide extended shafts on all volume dampers greater than the thickness of the insulation to provide free movement of damper positioner. Stiffen duct at damper location; install damper in manner to prevent rattling.
25. Provide square to round transition fittings with balancing dampers at all round duct take-offs to supply diffusers and registers.
26. Duct sizes are inside free area. Increase duct sizes as required.
27. Ductwork and accessories shall not be delivered to the job site until just prior to erection and shall be stored in an approved manner.
28. All ductwork shall be internally cleaned by vacuuming prior to installation.
29. All ductwork open ends shall be sealed with polyethylene and duct tape during construction after hanging.

B. Grilles, Registers, and Diffusers:

1. Refer to drawings for types, material, models, finishes, and manufacturers. Air devices shall have performance characteristics (throw, noise, and pressure drop) equal to air devices scheduled on the drawings. Provide performance data with submittal. PRICE, TITUS, GREENHECK, or equal.
2. Grille and register frames and louvers shall be one-piece construction.
3. Paint interior surfaces of ducts behind grilles and registers with flat black enamel.
4. Linear Slot Diffusers
 - a. Provide linear slot diffusers of types, material, models, and finishes as manufactured by PRICE, TITUS, GREENHECK, or equal. Air devices shall have performance characteristics (throw, noise, and pressure drop) equal to air devices scheduled on the drawings. This information shall be provided with the submittal.
 - b. Diffusers, frames, and accessory components shall be constructed of extruded aluminum with slots, borders, and frames of types and finish indicated.
 - c. Provide concealed mounting clips for securing diffuser to frame.
 - d. Diffusers shall have factory-fabricated galvanized-steel plenum casing with 1/2" foil backed fiberglass liner. Foil backing shall face the airstream.
 - e. Diffusers shall have adjustable air pattern controllers capable of full 180° air throw adjustments.
 - f. Furnish diffusers in a single piece.

C. Roof Curbs and Equipment Rails:

1. Provide 18-gauge galvanized roof curbs for all roof-mounted equipment where curbs are not otherwise specified. Curbs shall be insulated with wood nailers and be 14" in height. Curbs shall be constructed to match the slope of the roof where installed.

2. Provide 18-gauge galvanized equipment rail with unitized construction with integral base plate, continuous welded corner seams, pressure treated wood nailer, and counterflashing with stainless steel screws. Rail shall be internally reinforced to conform with the manufacturer's load bearing factors. Curb shall be 14" in height. Rails shall be RPS "ER-4A," PATE "ES-5," or KEES "RC."
 3. Construction
 - a. Frame: Galvanized steel in gauges required by manufacturer's UL listing.
 - b. Blades: Galvanized steel curtain style.
 - c. Sleeve: Damper shall be supplied with a factory sleeve.
 - d. Retaining Angles: Damper shall be supplied with factory retaining angles sized to provide installation overlap in accordance with the manufacturer's UL listing.
 - e. Fire Closure Device: Damper shall be supplied with fusible link.
 - f. Mounting: Dampers shall be mounted horizontally or vertically depending on the application. Refer to the Contract Drawings for required orientation.
 - g. Finish: Galvanized steel
 4. Installation
 - a. Install dampers in accordance with manufacturer's UL Installation Instructions, labeling, and NFPA 90A at locations indicated on the drawings. Any damper installation that is not in accordance with the manufacturer's UL Installation Instructions shall be approved prior to installation.
 - b. Dampers shall be accessible to allow inspection, adjustment, and replacement of components. The sheet metal contractor shall furnish any access doors in ductwork or plenums required to provide this access. The general contractor shall furnish any access doors required in walls, ceilings, or other general building construction. Dampers shall be provided with an access door that is not less than 12 inches square or provided with a removable duct section. Access doors shall be permanently identified on the exterior face with a 1" tall label.
 - c. Install dampers square and free from racking.
 - d. Do not compress or stretch the damper frame into the duct or opening.
 - e. Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Install support mullions as reinforcement between assemblies as required.
 - f. Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator, or jackshaft.
- D. Series Fan-Powered Variable Air Volume Terminal Boxes (Owner Furnished, Contractor Installed):
1. Terminal boxes shall be size, type, and capacity indicated on drawings. TRANE CO., or equal by PRICE, TITUS. Units shall be series fan-powered type as indicated. Units shall be ARI certified. Submit sound level data indicating radiated and discharge NC levels for each terminal unit at design airflows.

2. Units shall be complete with insulated casing, electric air valve, and direct digital controls. The direct digital controls shall be furnished by the Temperature Control Contractor and factory installed by the unit manufacturer.
 3. Casing: Provide 22-gauge, acoustically lined, galvanized-steel casing. Lining shall be 1" thick, 1.5-lb. per cubic foot density, foil faced, fibrous glass which meets requirements of NFPA 90A. Provide access panel for access to air valves.
 4. Primary Air Valve: Provide cylindrical volume control device with electric actuator. Valve inlet shall be 18 gauge steel cylinder sized to fit standard round flexible ductwork. Maximum leakage rate shall be 1% at 4" w.c. pressure differential. Provide with multiple point averaging flow sensor to provide primary airflow measurement within $\pm 5\%$ of rated unit airflow with 1-1/2 diameters of straight duct upstream of unit. Provide integral flow taps and calibration chart on each unit.
 5. Fan shall be forward-curved blade, with direct-drive, ECM motor, and disconnect switch.
 6. Provide 1" fiberglass media filter with filter frame in plenum intake or ducted inlet as indicated.
 7. Electric Reheat Coil: The coil shall factory provided and mounted on the discharge outlet. The coils have a resistance open-type heater with a disc-type automatic reset thermal primary safety device. Heater element material is nickel-chromium. Provide heaters with the following options:
 - a. Mercury Contactor: An electric heater contact for use with direct digital control or analog electronic controls.
 - b. Airflow Switch: An air pressure device designed to disable the heater when the unit fan is off.
 - c. Line Fuse: A safety fuse located in the electric heater's line of power to prevent power surge damage to the electric heater. A line fuse shall be provided for the fan motor to prevent power surge damage to the motor.
 - d. Disconnect Switch: A factory provided disconnect switch with an interlocking door on the heater control panel.
 8. Units shall have removable access panel or access door for service access.
 9. Units shall be installed with strict attention paid to manufacturer's recommended length of straight inlet duct.
 10. Automatic Controls: Provide factory-installed automatic (direct digital) controls provided by the control vendor. The control vendor shall furnish and variable volume terminal unit manufacturer shall install Direct Digital Controller. Controller shall provide the sequence of operation specified. Controller shall provide the required signals to achieve pressure independent operation throughout the specified volume range of the unit. Variable volume terminal unit manufacturer shall examine terminal unit locations indicated on drawings and shall locate controllers on most accessible side of unit. All costs associated with factory mounting of vendor's controls shall be included in this Section.
- E. Series Hot Water Heat Variable Air Volume Terminals (Owner Furnished, Contractor Installed):
1. General: Provide fan powered variable air volume series terminals complete with casing, fan section, primary air valve, hot water heating coil, and discharge plenum,

where indicated. Units shall be manufactured by TRANE CO., PRICE, or approved equal. Acoustical data shall be certified in accordance with ARI 880. Acoustical data shall consider effect of discharge plenum and outlet combination.

2. Casing: Provide 22-gauge, acoustically lined, galvanized-steel casing. The interior surface of the unit casing is acoustically and thermally lined with 1-inch, 1.5 lb/ft³ density glass fiber with foil facing. The insulation R-Value is 4.1. The insulation is UL listed and meets NFPA-90A and UL 181 standards as well as bacteriological standard ASTM C 665. There shall be no exposed edges of insulation (complete metal encapsulation).
3. Primary Air Valve: Maximum leakage rate shall be 1% at 4" w.c. pressure differential. Provide with multiple point averaging flow sensor to provide primary airflow measurement within $\pm 5\%$ of rated unit airflow with 1-1/2 diameters of straight duct upstream of unit. Provide integral flow taps and calibration chart on each unit.
4. Fan wheel shall be forward curved.
5. Motor shall be permanently lubricated, direct drive, permanent split capacitor type. Provide thermal overload protection. Maximum motor temperature rise on all speeds of 55°C. Motor voltage shall be as scheduled on the drawings. Motor and fan assembly shall be isolated from terminal casing using rubber isolators.
6. Factory mount variable speed (SCR) controller to adjust fan motor speed. Controller shall have minimum stop to avoid overheating of motor. The controller adjustment knob shall be located on the exterior of the control panel. Provide a factory mounted and wired fan disconnect switch.
7. Hot Water Heating Coil: Provide factory-mounted hot water heating coils constructed of seamless copper tubes and plate aluminum fins mechanically bonded to tubes. Coils shall be rated for a minimum working pressure of 150 psi. Coil performance shall be certified in accordance with ARI 410.
8. Factory mount controller and damper operator provided by BAS manufacturer. Furnish and install a 40-VA transformer.

F. Kitchen Hood Exhaust Ductwork – Double-Wall Grease Duct:

1. The grease duct shall be double-wall factory-built type for use with Type 1 kitchen hoods, as described in NFPA-96 for the venting of air and grease-laden vapors from commercial cooking operation.
2. Basis of design product shall be SCHEBLER "FYREGUARD," CAPTIVEAIRE "DW-2R/DW-3Z," JEREMIAS "DWFL-ZC," or equal.
3. Product Description
 - a. The factory-built modular grease duct shall be laboratory tested and listed in accordance with Underwriters Laboratories Standard UL 1978 and UL 2221 classified for zero clearance to combustibles with a 2-hour fire rating. Sections shall bear the UL listing mark. Modular grease duct shall be a 1/2" flange to flange connection and sections shall be coupled using RapidLock bands and joint sealant.
 - b. Construction: Between the inner and outer shells there shall be a minimum 4" of 1800°F rated low conductivity ceramic fiber insulation. The insulation shall be securely attached to the inner shell with steel straps and insulating pins welded to the inner shell. Stainless steel centering clips shall be welded to the outer shell to maintain the 4" spacing and ensure concentricity of the shells. Breeching and chimney sections, when installed according to

manufacturer's instructions, shall comply with national safety standards and building codes. Stacks terminating above a roof shall terminate as required by code or NFPA 211.

- c. Inner Shell: Inner shell material shall be type 304 stainless steel. Inner shell thickness shall be .036" for 5" to 36" diameter systems. All inner shell seams shall be fully penetration welded the entire length of the pipe section. Riveted, tack or spot-welded seams are not permitted.
- d. Outer Jacket: Standard 430 stainless steel outer shell thickness of .034" for 5" to 36" diameter systems. All outer shell seams shall be full-penetration-welded the entire length of the pipe section. Riveted, tack or spot-welded seams are not permitted.
- e. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
- f. Warranty: Manufacturer Lifetime Warranty for the entire duration the product is incorporated and used in its original installation when installed by manufacturer's provided UL installation instructions. System sizing and design shall be performed by manufacturer and installed in accordance with the installation instructions published.

4. Installation and Cleaning

- a. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- b. Seal between sections of grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- c. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- d. Slope breeches down in the direction of the appliance.
- e. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- f. Clean breeches internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film.
- g. Provide temporary closures at ends of stacks that are not completed or connected to equipment.

2.8 VIBRATION ISOLATION

- A. Mechanical equipment indicated below shall be isolated from the structure by resilient vibration and noise isolations. Equipment to be isolated includes, but is not limited to, the following:

- 1. Rooftop Air Handling Units
- 2. Cabinet Unit Heaters
- 3. Inline Exhaust Fans

4. Fan Powered VAV Terminal Units
 5. 4-way Cassettes
- B. Vibration Isolation Rail System (RTU's Only):
1. Curb mounted rooftop equipment shall be mounted on vibration isolation rails that fit over the roof curb and under the isolated equipment. Curb mounted isolation rails shall be MASON "RSC," VIBRO-ACOUSTICS "ARTR," MGM "ISORAIL," or equal.
 2. Curb mounted rooftop equipment shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame shall provide continuous support for the equipment and shall be captive to resiliently resist wind forces.
 3. All directional neoprene snubber bushings shall be a minimum of ¼" (6mm) thick. Steel springs shall be laterally stable and rest on ¼" (6mm) thick neoprene acoustical pads.
 4. Hardware shall be plated, and the springs provided with a rust resistant finish.
 5. The curbs waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curbs waterproofing and joined at the corners by EPDM bellows.
 6. All spring locations shall have access ports with removable waterproof covers.
 7. Lower curbs shall have provision for 2" (51mm) of insulation.
- C. Hanger and Guide Supports:
1. Spring Isolators:
 - a. Ceiling mounted cabinet unit heaters, series fan powered variable air volume terminal units... shall be suspended with vibration spring isolators. Isolators shall be MASON "30N," VIBRO-ACOUSTICS "SHRB," KINETICS "SRH," or equal.
 - b. Hangers shall consist of rigid steel frames containing minimum 1-1/4" thick neoprene elements at the top and a steel spring seated in a steel washer reinforced neoprene cup on the bottom. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability, the boxes shall not be articulated as clevis hangers, nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring.
- D. Rooftop Acoustical Systems: Provide acoustical material inside the roof curb as indicated on the Contract Drawings. Acoustical material shall be furnished by the isolation curb manufacturer, and consist of the following:
1. Vibration Isolation Rail System: Provide 2 layers of moisture resistant 5/8" gypsum board on top of 3/8" x 1-3/4" foam pads. Foam pads shall be mounted on 2" aluminum channel that extends the width of the curb rail. The aluminum channel shall be installed

above the spring isolator to attenuate acoustical vibrations translated through the roof curb.

2. Provide 2" thickness ROCKWOOL "AFB," OWENS-CORNING "705," or JOHNS MANVILLE "Insul-SHIELD" acoustic batt insulation with 2.8 lbs./sf density on top of the gypsum board.

2.9 MEASUREMENT AND CONTROL

A. Variable Frequency Drives

1. This specification covers a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with a standard NEMA Design B induction motor.
2. Provide variable speed frequency drive (VFD) units for the following equipment:
 - a. RTU Supply Fans
 - b. RTU Exhaust Fans
3. Acceptable VFD manufacturers are ABB, DANFOSS, TOSHIBA, or equal.
4. The VFD package as specified herein shall be enclosed in a UL Listed Type 1 enclosure for indoor applications, completely assembled and tested by the manufacturer in an ISO9001 facility.
 - a. Environmental operating conditions: VFDs shall be capable of continuous operation at 32 to 120 F ambient temperature or VFD shall be oversized to meet these temperature requirements.
 - b. Enclosure for indoor applications shall be rated UL Type 1, Enclosures for outdoor applications shall be UL Type 3R. All enclosures shall be UL listed as a plenum rated VFD.
5. All VFDs shall have a Short Circuit Withstand Rating of not less than the rating of the connected equipment in accordance with UL508.
6. All VFDs shall have the following standard features:
 - a. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference.
 - b. There shall be a built-in time clock in the VFD keypad.
 - c. The VFD's shall utilize pre-programmed application macros specifically designed to facilitate start-up.
 - d. The VFD shall have cooling fans that are designed for easy replacement.
 - e. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip.
 - f. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430.250 for 4-pole motors.
 - g. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients.

- h. The input current rating of the VFD shall be no more than 3% greater than the output current rating.
 - i. The VFD shall include a coordinated AC transient surge protection system.
 - j. The VFD shall provide a programmable loss-of-load Form-C relay output.
 - k. The VFD shall have user programmable underload and overload curve functions to allow user defined indications of mechanical failure / jam condition causing motor overload.
 - l. The VFD shall include multiple "two zone" PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4-20mA, 0-10V, and / or serial communications). The two zone control PID algorithm shall control motor speed based on a minimum, maximum, or average of the two feedback signals. All the VFD PID controllers shall include the ability for "two zone" control.
 - m. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user.
 - n. Door interlocked, pad lockable molded case switch that shall disconnect all input power from the drive and all internally mounted options.
7. All VFDs to have the following adjustments:
- a. Three (3) programmable critical frequency lockout ranges.
 - b. Two (2) PID Set point controllers allowing pressure or flow signals to be connected to the VFD.
 - c. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (i.e., valves, dampers, etc.). All set points, process variables, etc. shall be accessible from the serial communication network.
 - d. Two (2) programmable analog inputs shall accept current or voltage signals.
 - e. Two (2) programmable analog outputs (0-20ma or 4-20 ma).
 - f. Six (6) programmable digital inputs for flexibility in interfacing with external devices.
 - g. Three (3) programmable, digital Form-C relay outputs.
 - h. Run permissive circuit - There shall be a run permissive circuit for damper or valve control.
 - i. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active.
 - j. Seven (7) programmable preset speeds.
 - k. Two independently adjustable accel and decel ramps with 1 - 1800 seconds adjustable time ramps.
 - l. The VFD shall include a motor flux optimization circuit that shall automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise.
 - m. The VFD shall have selectable software for optimization of motor noise, energy consumption, and motor speed control.
 - n. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD.
 - o. The VFD shall include password protection against parameter changes.

8. The Keypad shall include a backlit LCD display. All VFD faults shall be displayed in English words. The keypad shall include the following assistants:
 - a. Start-up assistant
 - b. Parameter assistants
 - c. Maintenance assistant
 - d. Troubleshooting assistant
 - e. Drive optimizer assistants
9. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being always displayed:
 - a. Output Frequency
 - b. Motor Speed (RPM, %, or Engineering units)
 - c. Motor Current
 - d. Motor Torque
 - e. Motor Power (kW)
 - f. DC Bus Voltage
 - g. Output Voltage
10. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fire / smoke control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed. 2) Operate in a specific fireman's override PID algorithm. The mode shall override all other inputs except customer defined safety run interlocks and force the motor to run in one of the two modes above.
11. Serial Communications
 - a. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet. Optional protocols for LonWorks, Profibus, EtherNet, BACnet IP, and DeviceNet shall be available.
 - b. The BACnet connection shall be an EIA-485, MS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
 - 1) Data Sharing - Read Property - B.
 - 2) Data Sharing - Write Property - B.
 - 3) Device Management - Dynamic Device Binding (Who-Is; I-Am).
 - 4) Device Management - Dynamic Object Binding (Who-Has; I-Have).
 - 5) Device Management - Communication Control - B.
 - c. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency,

- current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.
- d. Serial communication in bypass shall include, but not be limited to; bypass run-stop control, the ability to force the unit to bypass, and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible.
 - e. The VFD / bypass shall allow the DDC to control the drive and bypass digital and analog outputs via the serial interface. This control shall be independent of any VFD function.
 - f. The VFD shall include an independent PID loop for customer use.
- 12. EMI / RFI filters. All VFD's shall include EMI/RFI filters.
 - 13. All VFD's through 75HP at 480 V shall be protected from input and output power mis-wiring.
 - 14. Bypass Controller
 - a. A complete factory wired and tested bypass system shall be provided with the following operators:
 - 1) Bypass Hand-Off-Auto
 - 2) Drive mode selector
 - 3) Bypass mode selector
 - 4) Bypass fault reset
 - b. The bypass shall include an LCD display that allows the user to access owner requested data including but not limited to failures, bypass power (KW), and energy savings.
 - c. The following indicating lights (LED type), or keypad display indications shall be provided.
 - 15. Emergency Stop Function
 - a. An emergency stop function shall meet all the following requirements:
 - 1) The function shall override all other functions and operations under all conditions.
 - 2) Reset shall not initiate a restart.
 - 3) An emergency stop shall operate in such a way that, when it is activated, the hazardous movement of the machinery is stopped and the machine is unable to start under any circumstances, even after the

emergency stop is released. Releasing the emergency stop only allows the machine to be restarted.

- 4) The emergency stop shall stop hazardous movement by applying a stop category 0.
 - a) Emergency stop category 0 (according to EN 60204-1) means that the power to the motor shall cut off immediately. Stop category 0 is equivalent to the safe torque off (STO) function, as defined by standard EN/IEC 61800-5-2.
16. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the VFD installation manual.
17. Power wiring shall be completed by the electrical contractor, to NEC code 430.122 wiring requirements based on the VFD input current.
18. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file with the manufacturer.
19. The VFD Product Warranty shall be 24 months from the date of certified start-up. The warranty shall include all parts, labor, travel time and expenses. There shall be 365/24 support available via a toll-free phone number.

B. Low Voltage Condensate Overflow Shut-off Switch

1. Low voltage condensate overflow shut-off switches shall be installed on all condensate drain pans as manufactured by RECTORSEAL "AquaGuard," LITTLE GIANT "ACS-2," ASURITY "CC-1," or equal.
2. Mechanical equipment without adequate pan clearance to install a primary drain pan switch shall provide a switch installed on the primary drain pan outlet. The condensate shut-off switch shall detect downstream clogs in condensate drains and interrupts the thermostat circuit to shut off the unit before flooding occurs. Switch shall be RECTORSEAL "Safe-T-Switch," LITTLE GIANT "ACS-5," ASURITY "CS-1," or equal.
3. The condensate shut-off switch shall detect rising water in condensate drain pans and interrupts the thermostat circuit to shut off the unit before flooding occurs. The device shall be installed on the primary drain pan rim with a two-piece clamp system that does not require drilling.
4. The switch shall incorporate a high capacity 5-amp, 24-volt AC magnetic float switch in a fully housed protective cover. The housing shall include a pull up test knob for functional testing of system.
5. The switch shall include an alarm wire to connect to the BAS. The switch shall send an alarm signal to the BAS front-end workstation. The mechanical contractor shall be responsible for coordinating the switch connections with the controls contractor.
6. The switch shall be UL Listed to comply with UL 508.

C. Bipolar Ionization

1. This section describes the design, performance, and installation of a needlepoint bipolar ionization (NBPI) air purification system intended for use as part of another

manufacturer's air handling unit or mounted on the duct as shown on the plans, details, and equipment schedules.

2. Project Design

- a. Maximum ozone emissions shall be in accordance with limits stated in UL 2998. Provide products listed as UL2998-compliant.
- b. Provide ionization device that does not require preheat protection when relative humidity of entering air exceeds 85%. Device shall be suitable for relative humidity from 0-100%, condensing, without causing damage, deterioration, or dangerous conditions within air ionization system.
- c. Provide systems that produce positive and negative ions. Unipolar ionization devices are unacceptable.
- d. Device shall be tested by UL, proving compliance with UL 2998 ozone standard when tested using UL 867 (5th edition) methodology. Perform large chamber testing and peak ozone test for electronic devices in accordance with UL 2998.

- 1) Demonstrate interior ion concentration levels, both positive and negative collectively, to minimum 2000 ions/cc measured 5 ft from floor where air is delivered from the duct system
- 2) Provide ionization systems suitable for air exchange rates through full operating range of constant volume or variable air volume (VAV) system.
- 3) Minimum air velocity: 300 fpm

- e. Provide ionization device enclosures constructed of corrosion-resistant, non-metallic materials. Configure enclosure without thermal bridging. Provide units certified to UL 2998.
- f. Provide ionization units having manufacturer's recommended number of electrodes and power generators, sized to system air flow.
- g. Electrodes shall consist of carbon fiber clusters having minimum 45000 needles each.
- h. Ionization system shall be energized continuously.
- i. Additional Design Requirements for Non-Auto Coil Cleaning Installations:

- 1) Multi-voltage input shall allow 24V or 110-240VAC power supply.
- 2) Provide magnets for mounting ionization system to fan inlet.
- 3) Provide integral alarm dry contacts, SPST (NO), rated 0.3 A at 125VAC.

j. Additional Design Requirements for Auto Coil Cleaning Installations:

- 1) Provide electrodes in six-inch sections for field assembly by installer to cover entire finned width of coil.
- 2) Provide one modular ionization bar for every 5ft. of coil height.
- 3) Electrode spacing shall be 0.5 to 1 inch apart.
- 4) Output shall be 140 million ions/cc per inch of bar, measured 1 inch from carbon fiber brushes.
- 5) Ionization Bars:

- a) Length shall be 12 ft. maximum

- b) Provide ac power supply for field installation, capable of powering four ionization bars requiring 20W each.
 - c) Include integral on/off switch and LED “power on” light.
 - d) Include BAS interface alarm dry contacts, SPST (NO), rated 1A at 250VAC.
 - e) Power source shall be 24VAC, 110VAC, or 208-240VAC.
 - f) Power supply enclosure class shall be NEMA 250, Type 4.
 - k. NPBI devices shall be provided with internal short-circuit protection, overload protection, and automatic fault reset circuit breakers.
3. General Installation
- a. Position each electronic air cleaner unit with clearance for service and maintenance. Anchor electronic air cleaners to substrate.
 - b. Install air cleaner devices between upstream filter and cooling coil. Where unit configuration does not allow this installation location, air cleaner devices shall be installed upstream or downstream of supply fan.
4. Factory-fabricated, modular bipolar ionization device
- a. Subject to compliance with requirements, provide GPS “i-MOD,” PHENOMENAL AIRE “Series C Universal,” ATMOSAIR “ActiveOx R” or equal.
 - b. Capacity and Characteristics
 - 1) Materials: Composite and carbon fiber
 - 2) Capacity: 50 to 250 cfm per inch of length
 - 3) Voltage selector switch and illuminated on-off switch
 - 4) LED operational status light
 - 5) Six high-voltage output connections
 - 6) Alarm contacts: SPDT, dry
 - 7) Auxiliary terminals for connections of remote ion sensor
 - 8) Temperature range: -40°F to 140°F
 - 9) Relative humidity range: 0-100%
 - 10) Power Entry: UL listed, line cord with three-prong plug
 - 11) Power unit dimensions: 9” L x 3.25” W x 4.75”H
 - 12) Ionizer bar dimensions: 1.6”H x 0.75” W
 - a) Length per section: 6 inches, having nine brushes per section
 - b) Maximum assembled bar length: 144 inches
 - c) Provide rare earth magnets for mounting
 - 13) Power unit weight: 4.63lb
 - 14) Ionizer bar weight: 0.24lb per 6-inch section
 - c. Electrical Characteristics
 - 1) Electrical Listings: UL/ETL
 - 2) Compliance and Certifications: IAQP, UL 867, UL 2043, UL 2998

- 3) Input voltage: 24V AC or DC, 110VAC, 240VAC
 - 4) Amperes: 0.5A at 24V, 0.12A at 110V, 0.1A at 240V
 - 5) Output power: 5 kV RMS
 - 6) Total ion output: 140 million ions/cc per inch of bar, measured 1 inch from carbon fiber brushes
- d. Provide ion sensor compatible with ionization device.
 - e. Provide one ionization bar assembly on each coil up to 60 inches in height. Space bars maximum 60 inches apart. Install bar to cover entire finned width of coil to nearest 6 inches without exceeding finned width of coil.

PART 3 - EXECUTION

3.1 TESTS

- A. Refer to Section 230593 "Testing, Adjusting and Balancing" for related requirements.
- B. At their discretion, the Owner shall be represented at all tests. Contractor shall provide 48 hours' notice to the Owner prior to the tests unless otherwise specified.
- C. Before insulation is installed and before piping is concealed, test water piping hydrostatically and prove tight under 100 psig pressure. Test pressure shall be held for minimum of 8 hours. An air test in lieu of water may be used when danger of freezing is possible and when approved.
- D. Refrigerant piping shall be tested with dry nitrogen and trace of refrigerant at test pressures recommended by equipment manufacturer. After system has been proven tight under test pressure, it shall be evacuated to a pressure 2.5 mm Hg absolute. The refrigerant compressor shall not be used for evacuating the system. Vacuum shall be checked by use of a mercury manometer.

3.2 EQUIPMENT COORDINATION

- A. The Prime contractor shall conduct an HVAC Coordination meeting after submission of the HVAC equipment, fire alarm, and controls submittals to the Engineer, and prior to the return of the reviewed controls submittal to the Prime Contractor. The Prime Contractor shall coordinate the meeting time, date, and location with all parties, provide a written agenda, provide written meeting minutes, and provide a detailed issues summary (if unresolved issues remain open after the meeting).
- B. The Prime Contractor shall provide follow-up action as required with the following in mandatory attendance:
 - 1. Prime Contractor Project Manager and Project Superintendent
 - 2. Equipment manufacturer technical services representative (not a sales representative)
 - 3. Controls contractor technical services representative (not a sales representative)
 - 4. Mechanical engineer
 - 5. Owner's representative

6. Fire alarm system representative

- C. The purpose of this meeting is to review equipment, control sequences, and the selected manufacturer's available control points. Upon completion of this meeting, the General Contractor shall be required to submit a meeting report detailing all discussed issues and coordinated solutions. Any unresolved issues shall require another mandatory meeting to ensure all items have been considered and coordinated prior to construction.

3.3 DUCTWORK LEAKAGE TESTING

- A. Test all medium pressure supply duct systems to determine the leakage in the systems. The leakage testing shall be performed in accordance with the requirements of SMACNA - ADLTM in presence of Owner or Owner's Representative.
- B. Coordinate test opening size requirements with the test equipment.
- C. Coordinate scheduling of tests and all preparations for tests with the Engineer and Owner. The Contractor's air balancing Contractor and Owner shall witness all leak tests.
- D. All medium and high pressure supply air ductwork shall be leak tested at 4.0" w.c. Allowable leakage shall be in accordance with SMACNA HVAC Air Duct Leakage Test Manual.
- E. The air balancing Contractor shall review the test results and provide recommendations for repair and/or modification to any systems which do not meet the allowable leakage rate criteria. Once repairs and/or modifications are complete, the Contractor shall repeat the leakage testing. This process shall continue until the system meets or exceeds the allowable leakage rate criteria. Additional testing shall be performed at the Contractor's expense.
- F. Leakage testing shall be performed prior to above ceiling Punch List, insulation of the ductwork and installation of the finished ceilings.
- G. Forward all test results to the Engineer for review. Provide copy of all tests to Owner upon completion.

END OF SECTION 230500

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SECTION 230593 - TESTING, ADJUSTING AND BALANCING (TAB)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and Section 230100 "Mechanical General Provisions" apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SCOPE OF WORK

- A. The General Contractor shall obtain the services of an independent testing and balancing agency whose business is limited to testing, adjusting and balancing and shall be certified by AABC (or NEBB). Agency shall have been in the TAB business for a minimum of 5 years. The TAB (Testing, Adjusting and Balancing) Agency shall be a direct subcontractor of the General Contractor and not affiliated in any way with the Mechanical Contractor.
- B. Testing and balancing shall be performed in accordance with National Standards for Testing and Balancing Heating, Ventilating and Air-conditioning Systems, 2002, as published by Associated Air Balance Council (AABC).
- C. All work shall be performed under the direct supervision of a certified TAB Engineer. All other personnel shall be regular full-time employees of the TAB Agency.
- D. Test and Balance Agency shall submit within 30 days after receipt of construction contract two copies of qualifications, including current TAB Engineer's certificate and National Project Certification Performance Guaranty.
- E. TAB work shall not commence until all components of the HVAC system have been installed completely, including all power wiring and controls and all equipment has been started and run tested in each mode of operation. Should any items be found incomplete at the time that TAB work is performed, the TAB Agency shall immediately notify the General Contractor and Owner's Representative of any deficiencies found. The General Contractor shall be responsible for correcting reported deficiencies and verifying that the system is 100% complete, operable and ready for TAB work to proceed.

PART 2 - PRODUCTS

2.1 MATERIAL AND EQUIPMENT

- A. Provide all necessary instrumentation required to measure and adjust the HVAC air and water systems.
- B. Equipment and instruments shall be of types approved by the Owner's Representative and/or manufacturers of devices installed.
- C. Instruments used for testing and balancing of air and hydronic systems shall have calibration verified within a period of 12 months prior to balancing.

PART 3 - EXECUTION

3.1 GENERAL, MECHANICAL AND ELECTRICAL CONTRACTOR'S RESPONSIBILITY

- A. The General Contractor shall be responsible for directing the Mechanical and Electrical Contractors to fulfill the Contractors' Responsibility for Testing, Adjusting and Balancing as required in Section 230100. TAB work shall not commence until the conditions of paragraph 1.2.E of this Section and all requirements of Section 230100 for TAB have been completed.

3.2 TAB AGENCY'S RESPONSIBILITY

- A. Carefully review the drawings and Specifications for the various systems noting all facilities incorporated in the design for purposes of adjusting and balancing. Should it be deemed necessary to provide additional dampers, baffles, valves, or other devices which would aid in the required adjusting and balancing, same shall be provided by the installing contractor.
- B. The TAB Agency shall report any and all deficiencies that prohibit adjusting and balancing in accordance with the Contract Documents to the Contractor and the Owner's Representative.
- C. Adjust all water piping, duct and equipment, including valves, controls, dampers, cocks, etc., to properly perform to $\pm 10\%$ of their respective design quantities of flow.
- D. Determination of the air volumes shall be made by pitot tube and differential draft gauge for all supply, return, outdoor air and exhaust air ducts. Openings for pitot traverses shall be provided as required and shall be fitted with neat removable plugs or covers. Air quantities at grilles, registers, diffusers, etc., shall be measured as recommended by the various manufacturers of the outlets.
 - 1. Fan powered VAV boxes shall be balanced in a manner that assures the design primary airflow is delivered to the VAV box at maximum and minimum air flow. The manufacturer provided flow measurement device may or may not be accurate due to upstream duct conditions. (See 3.2.H.7 for reporting requirements.)
- E. The Test and Balance Agency shall perform the following:
 - 1. Adjust fan RPM, tighten and align fan belts, measure operating amps.
 - 2. Adjust volume dampers to obtain designed air volume.

3. Adjust grilles, diffusers and registers to obtain designed airflow and air pattern.
 4. Set balancing valves to obtain designed water flow at units, coils and branches.
 5. Adjust each air handler to obtain designed airflow.
 6. Adjust dampers to provide design outside air quantities.
 7. In cooperation with the ATC Contractor's representative, setting adjustments of automatically controlled dampers to operate as specified. The TAB Agency shall inform ATC Contractor of all abnormalities in sequencing and/or calibration of components discovered during balancing.
 8. Final settings of dampers and valves shall be permanently marked. Where provided, memory stops and locking devices shall be adjusted and locked to the final setting.
 9. Assist Fire Alarm Contractor in the testing of all duct smoke detectors. Measure the air velocity across each duct smoke detector with air handling unit at full airflow.
- F. Before the work is offered for Final Acceptance, all equipment shall be run through a test to demonstrate that it has been adjusted to meet the requirements of the drawings and Specifications. Copies of the test and adjustment data shall be submitted in a report to the Owner's Representative prior to final inspection.
- G. The TAB Report shall include a General Comments section providing an overview of systems operation, observations of system installation abnormalities and deficiencies, problems encountered, etc. If required, provide explanation of methods of measurement and disparity between measured and design quantities.
- H. Test and Balance Agency Report shall include the following data for each system. All sheets shall be neatly typed. Balancing Agency shall submit with his report a set of neatly marked plans identifying location of each piece of equipment, air terminal, flow measuring device and points of traverse. Report all measured quantities and design quantities where applicable.
1. CFM of each supply, return, exhaust grille and diffuser.
 2. RPM and CFM of each fan.
 3. Supply, return and outdoor air CFM of each AHU and fan terminal unit where required.
 4. Air pressure drop across A/C unit cooling and heating coils.
 5. Air pressure drop across each filter bank.
 6. Discharge and suction static pressure of each fan.
 7. Maximum and minimum differential pressure and corresponding CFM of each terminal box.
 8. Voltage rating and operating volts of each fan motor. For fan motors requiring three-phase power, record voltage of each individual phased leg and check for voltage imbalance.
 9. Temperatures for each air handling unit at maximum capacity including the following measurements:
 - a. Entering and Leaving air temperature at each coil.
 - b. Entering and Leaving water temperature at each coil.
 10. Air Handling unit is defined as any equipment that consists of a fan and coil, including rooftop air conditioning units, fan powered terminal units, cabinet unit heaters, unit heaters, etc.
 11. Nameplate data of each piece of HVAC equipment installed.

12. Differential pressure and corresponding GPM across each flow measuring device, including automatic flow control devices.
 13. Final percent setting after adjustment of each balancing valve where applicable.
 14. Velocity across each duct smoke detector at full airflow.
-
- I. During the Final Inspection, the Agency shall have present all necessary instrumentation and an individual to make readings of select information which was submitted in the balance report. The select readings shall be made where directed by and in the presence of the Owner's Representative and shall not deviate more than 5% from the values submitted in the report.
 - J. The Owner's Representative may select no more than 20% of all reported data for rechecking. If more than 20% of data verified is not within $\pm 5\%$ of submitted data, the Owner's Representative may void entire report and ask for complete rebalancing. The field check shall be made within 45 days of approved TAB submittal.

END OF SECTION 230593

SECTION 230700 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and Section 230100 "Mechanical General Provisions" apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SUBMITTALS

- A. Submit manufacturers' data on all insulation products, schedule which indicates where each product is to be used and thickness of each product.

1.3 WARRANTY-GUARANTEE

- A. Contractor shall furnish written warranty, countersigned and guaranteed by the General Contractor, stating that work executed under this Section of the Specifications shall be free from defects of materials and workmanship for a period of 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 INSULATION – GENERAL

- A. All insulation shall have a composite (insulation, jacket or facing and adhesive used to adhere the facing or jacket to the insulation) fire and smoke rating as requested by ASTM E84, NFPA 255 and UL 723, not exceeding:

| | |
|-----------------|----|
| Flame spread | 25 |
| Smoke developed | 50 |
- B. Accessories, such as adhesive, mastics, cements, tapes and fire-resistant cloth for fittings, shall have same fire and smoke ratings as components listed above.
- C. Installation of insulation shall be accomplished in strict accordance with manufacturer's recommendations and shall be CERTAINTEED, OWENS-CORNING, JOHNS MANVILLE or KNAUF INSULATION for glass fiber insulation; ARMACELL, AEROFLEX, or AEROFOAM for flexible unicellular insulation.

2.2 PIPE INSULATION

- A. Glass fiber insulation having a thermal conductivity not greater than 0.24 Btu x in./hr. x sq. ft. x °F in a mean temperature of 75°F. Insulation shall have factory-applied all-purpose jacket.
- B. Flexible unicellular insulation having a thermal conductivity not greater than 0.27 Btu x in./hr. x sq. ft. x °F in a mean temperature of 75°F.

2.3 DUCT INSULATION

- A. Blanket Type for concealed ductwork within the conditioned space: Glass fiber, ¾-lbs/cu. ft., foil faced, vapor-sealed flexible duct insulation. Thermal conductivity shall not exceed 0.29 Btu x in./hr. x sq. ft. x °F.
- B. Blanket Type in unconditioned spaces including attics: Glass fiber, 1-1/2-lbs/cu. ft., foil faced, vapor-sealed flexible duct insulation. Thermal conductivity shall not exceed 0.25 Btu x in./hr. x sq. ft. x °F.
- C. For the purposes of this Section, unconditioned space shall be defined as any area not directly served by supply ductwork. Plenum spaces shall be considered conditioned. Attics, mezzanines, and mechanical rooms shall all be considered unconditioned.

2.4 ACOUSTIC DUCT LINER

- A. Fiberglass duct liner shall not be used.

2.5 INSULATED DUCT COATING

- A. Provide insulated duct coating on all exterior galvanized sheet metal ductwork, POLAR SEAL, ASTEC, or approved equal.
 - 1. Water based acrylic plastic primer “prime security” shall provide 100% adhesion to substrate, stop oil migration and set base for waterproof membrane “top security”.
 - 2. Water-based acrylic plastic waterproof membrane “top security” with bright white reflective heat shield consisting of a high concentrate of titanium dioxide to reflect ultraviolet rays.
 - 3. Membrane “top security” shall be non-chalking, mildew and fungus resistant and crack resistant.
 - 4. Membrane “top security” shall be capable of withstanding sub-zero and extreme heat conditions without degradation. Membrane shall not shrink or become brittle because of age. Membrane shall be resistant to environmental pollution and other chemicals, such as ammonia, chlorine, insecticides, herbicides and other common airborne chemicals.

2.6 ALUMINUM PIPE JACKETS

- A. Aluminum jacket shall be .016" thick (28 ga.) smooth aluminum sized to provide a minimum 2" self-gauging overlap longitudinal and circumferentially, minimum 3/4" by .015" thick (30 ga.) draw bands. Jacket shall be supplied with a factory-applied polykraft moisture barrier. CHILDERS PRODUCTS COMPANY, STRAP-ON JACKETING.
- B. Provide fitting covers of same material as jacket and of same manufacturer.

2.7 CALCIUM SILICATE PIPE INSULATION INSERTS

- A. Calcium silicate pipe insulation inserts shall be provided at all points of contact between hangers and insulated piping larger than 1-1/2".
- B. Calcium silicate meeting ASTM C533, Type I, water resistant; rigid molded pipe; asbestos-free JOHNS MANVILLE Thermo-1200, or approved equal.
- C. Thermal conductivity of 0.437 Btu at 300°F mean temperature as tested in accordance with ASTM C335.
- D. Minimum compressive strength of 100 psi to produce 5% compression at 1-1/2" thickness.
- E. Non-combustible as determined by test complying with ASTM E136.
- F. Inserts shall have sufficient compressive strength to adequately support the pipe without compressing the inserts to a thickness less than the adjacent insulation. Insulation inserts shall cover the bottom half of the pipe circumference 180 degrees and be not less in length than the protection shield. Vapor-barrier facing of the insert shall be of the same material as the facing on the adjacent insulation.

2.8 PVC PIPE JACKET FITTING COVERS

- A. One-piece molded-type PVC plastic fitting covers and jacketing material, color matching JOHNS MANVILLE Zeston 2000, or approved equal.
- B. Connections shall be made using pressure-sensitive color matching vinyl tape.

2.9 FIRE WRAP

- A. Acceptable Manufacturer: THERMAL CERAMICS: 2102 Old Savannah Rd., Augusta, GA 30906; or approved equal.
- B. Thermal Material: 2000°F rated core blanket, manufactured from patented bio-soluble Superwool chemistry (Calcium Magnesium Silicate).
 - 1. Product: FireMaster FastWrap XL as manufactured by THERMAL CERAMICS.

- a. Insulation enclosure system tested and classified by UL (HNKT G18) to provide zero clearance to combustible construction and 2-hour fire rating per ASTM E 2336.
2. Fully encapsulated thermal material in fiberglass reinforced aluminum/polypropylene scrim.
 - a. Encapsulation material marked with UL Classification Mark.
 - b. Encapsulation material marked with ICC-ES report number ESR 2213.
 - c. Collars supplied in 6-inch (150 mm) wide by 25 feet (7620 mm) long rolls.
3. Product Characteristics:
 - a. Thickness: 1-1/2" ((38 mm).
 - b. Nominal Density: of 6 pcf
 - c. R-Value: 7.35 per layer of FireMaster Fast Wrap XL when tested in accordance with ASTM C518.
 - d. Flame Spread: <25 when tested in accordance with ASTM E 84.
 - e. Smoke Development: <50 when tested in accordance with ASTM E 84.
- C. Accessory Materials:
 1. Glass Filament Tape: Minimum ¾ inch (19 mm) wide – used to temporarily secure blanket until permanent attachment using steel banding and/or steel insulation pins.
 2. Aluminum foil Tape: Minimum 3 inches (76mm) used to seal cut edges.
 3. Carbon Steel or Stainless Strapping Material Minimum: ½ inch (13 mm) wide and 0.015 inch (.38 mm) thick.
 4. Steel Insulation Pins: Minimum 12-gauge, length sufficient to penetrate through duct wrap insulation.
 5. Insulation Clips: Galvanized steel, minimum 1-1/2 inches (38 mm) round or square.
 6. Through Penetration Firestop Sealants:
 - a. Packing Material: Remove encapsulation material from FastWrap XL, use core blanket (white) as penetration packing material.
 - b. Firestop sealants per applicable building code report and/or laboratory design listings.
 7. Grease Duct Access Doors:
 - a. Field fabricated access doors per Thermal Ceramics installation instructions.
 - b. DuctMate F2-HT Doors (NFPA 96 Compliant, tested with FireMaster FastWrap XL per ASTM E 2336)
 - c. DuctMate Ultimate Door (NFPA 96 Compliant, UL Listed per UL 1978, tested with FireMaster FastWrap XL per ASTM E 2336)
 - d. FireMaster DuctMate F2-HT-XL3 Access doors are supplied as a complete installation with DuctMate F2-HT Door and 3 layers of FastWrap XL insulation installed as tested in accordance with ASTM E 2336. Supplied in standard door sizes of 6 by10 inches (152 mm by 254 mm), 8 by 12 inches

(203 mm by 305 mm), 12 by 16 inches (305 mm by 406 mm) and 14 by 18 inches (356 mm by 457 mm).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Insulation shall be installed by a licensed applicator and in strict accordance with the manufacturer's instructions. Deliver all materials to the job site and store in a safe, dry place. Use all means necessary at the job site to protect materials from dust, dirt, moisture and physical abuse before and during installation. Insulation that becomes damaged prior to installation shall not be installed and shall be removed from the job site. Insulation that becomes wet or damaged after installation shall be removed and disposed of and replaced with new insulation.
- B. Surfaces to be insulated shall be cleaned free of dirt, scale, moisture, oil and grease prior to installation of the insulation.

3.2 PIPING (GLASS FIBER INSULATION, UNLESS OTHERWISE NOTED)

A. Schedule:

| | |
|---|--|
| Domestic Cold Water | 1/2" thickness for pipe sizes up to 1-1/4" 1" thickness for pipe sizes over 1-1/4" |
| Domestic Hot Water, Tempered Water, and Recirculating Hot Water (85-110°F) | 1" thickness for pipe sizes up to 1-1/2" 1-1/2" thickness for pipe sizes over 1-1/2" |
| Hot Water Heating and Dual Temperature Water (140°F and above) | 1-1/2" thickness for pipe sizes up to 1-1/2" 2" thickness for pipe sizes over 1-1/2" |
| Refrigerant Piping | 1/2" thickness flexible unicellular for all liquid piping. 1" thickness flexible unicellular for vapor (suction) piping up to 1- 1/2". 1-1/2" thickness flexible unicellular for vapor (suction) piping over 1-1/2". |
| Condensate drain above floor | 1/2" thickness |
| Storm and Sanitary Drains above floor that receive condensate | 1/2" thickness |
| Rain Leaders and Overflow Rain Leaders, including Roof drain and Overflow Roof Drain Bodies | 1" thickness, except insulation not required where piping is concealed in walls |

- B. Fittings and valves on insulated piping smaller than 4" shall be insulated with fiberglass blanket to thickness equal to adjoining pipe insulation unless otherwise noted. On all fittings

and valves, insulation shall be finished with a preformed PVC jacket. Finish all edges of insulation with mastic sealant to ensure no insulation is exposed.

- C. All valves and piping accessories above ceilings handling cold water shall be completely insulated to prevent condensation. Insulation installed on cold water valves shall be fully removable at the valve stem to facilitate valve operation while maintaining thermal barrier.
- D. Fittings and valves on refrigerant suction piping shall be insulated with cut sections of flexible unicellular insulation of thickness equal to adjoining pipe insulation.
- E. All flexible unicellular and glass fiber piping insulation exposed to the weather shall be provided with aluminum jacketing.
- F. No piping shall be insulated until it has been tested and thoroughly cleaned.
- G. Provide pipe inserts between pipe hanger support shields and on piping 1-1/2" diameter or larger. Insulation inserts shall not be less in length than 10".
- H. Hangers and supports for cold, or chilled water piping shall not injure or pierce insulation.

3.3 DUCTWORK

A. Definitions:

- 1. Concealed: Ductwork which shall be hidden from view by ceilings, walls, chases, or soffits, either by the work of this Contract, or by future tenant build-out work.
- 2. Exposed: Ductwork which is permanently in view, typically found in mechanical, storage, electrical, or other unfinished space.
- 3. Unconditioned space: Any area not directly served by supply ductwork. Plenum spaces shall be considered conditioned. Attics, mezzanines, and mechanical rooms shall all be considered unconditioned

B. Schedule:

| | |
|---|----------------------|
| Concealed Supply and Return, Air Ductwork Externally Insulated: (inside the conditioned space) | 2" thickness blanket |
|---|----------------------|

| | |
|--|----------------------|
| Concealed Supply and Return, Air Ductwork Externally Insulated: (inside the unconditioned space including attics) | 2" thickness blanket |
|--|----------------------|

| | |
|---|--------------------------|
| Exposed Supply and Return, Air Ductwork Externally Insulated: (In all mechanical rooms and mechanical mezzanines) | 2" thickness rigid board |
|---|--------------------------|

| | |
|--|---|
| Plenums: | 2" thickness (or externally insulate with 2" blanket or 1-1/2" rigid board) |
| Transfer Ducts: | Not Required |
| Exhaust Ducts: | Not Required |
| Factory Insulated Casings and Plenums | Not Required |
| Factory Insulated Double Wall Ductwork | Not Required |

- C. Insulate necks and tops of all supply air diffusers, registers and grilles.
- D. Finish all edges of insulation with mastic sealant to ensure no insulation is exposed, where installed outdoors or in unconditioned spaces.
- E. Where installed in conditioned spaces, blanket-type insulation shall be stapled and finished with mastic sealant in accordance with manufacturer's instructions.
- F. Insulation on ductwork over 16" in height or width must be attached with stick pins. When using self-adhesive pins, prepare surface to be applied to ensure adhesion.
- G. Insulation on flexible connections to VAV terminal units shall be stretched over the metal band and taped to the inlet and outlet connections of the VAV terminal unit.

3.4 INSULATED DUCT COATING

- A. Clean galvanized outer surface of sheet metal ductwork as recommended by the manufacturer of the duct coating.
- B. Apply first primer coat of insulated duct coating over all exposed ductwork at a rate of 100 square feet per gallon. Use polyester scrim over any joints or open areas. Completely saturate scrim in the first primer coat of duct coating.
- C. After first primer coat is dry (dries from milky white when wet to clear opaque when dry), apply second primer coat at a rate of 100 square feet per gallon and let dry.
- D. Apply top coat of insulated duct coating at a rate of 100 square feet per gallon and allow to dry.
- E. After first top coat is dry, apply a second top coat of insulated duct coating at a rate of 100 square feet per gallon.

3.5 SELF-ADHESIVE, FIELD-APPLIED, OUTDOOR JACKETS

- A. Ducts shall be sealed in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible - Second Edition (1995) Seal Class B (or latest version of SMACNA) prior to installation of insulation and the outdoor, field-applied jacket.

- B. Outdoor, field-applied insulation and jacket on ductwork insulation shall be pitched to shed water and prevent water ponding on top of the duct.
 - C. Fiberglass insulations shall have a factory applied FSK facing. Contractor shall be responsible for testing adhesion to any substrate.
 - D. Substrate surfaces shall be clean, dry, and free of oil films.
 - E. Select outdoor, field-applied jacket materials in accordance with manufacturer's instructions for coverage on the underside of the ductwork, to avoid pins.
 - F. Contractor shall adhere to the following duct installation criteria for proper maintenance of vapor barrier and physical integrity:
 - 1. Board insulation shall be mechanically installed on properly sealed ductwork according to the specifications using insulation fasteners (mini-cup weld pins or perforated, based pins and washers).
 - 2. Washers shall be covered with a 4-inch square piece of smooth foil tape prior to jacketing the ductwork to prevent the puncture of the outer membrane by the fasteners.
 - 3. Insulation on the top of the ductwork shall be installed to allow for the water to shed from the top of the duct and to prevent water from ponding on the top of the duct.
 - G. Contractor shall follow one of the options below for the installation of the outdoor, field-applied jacket depending on the jacket product and the duct sizes:
 - 1. Two-Piece Installation.
 - 2. Four-Piece Installation.
 - H. Contractor shall protect outdoor, field-applied jackets from damaging chemicals. Solvation will occur to the rubberized bitumen when exposed to petroleum or coal tar based compounds. Contact the manufacturer immediately for more information if there is doubt, before any chemical interaction.
 - I. Contractor shall allow each piece of the outdoor, field-applied jacket to stretch by using a 6-inch lap over the circumferential lap, and a 4-inch wide butt lap or overlap over the joint, and then roll with a roller. Position longitudinal laps at a water shed position.
 - J. Contractor shall not pre-apply the outdoor, field-applied jacket to fabricated insulation unless metal banding is used. Outdoor, field-applied jackets are not mechanical fastening systems and will not hold the insulation on the duct.
- 3.6 FIREWRAP
- A. Do not begin installation until substrates have been properly prepared.
 - B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
 - C. Preparation:

1. Remove dirt and dust from surfaces of openings and items penetrating rated floors and rated walls.

D. Installation:

1. Install Firewrap in direct contact with the ductwork in accordance with manufacturer's instructions, applicable laboratory listings and building code reports and referenced standards. For additional complex duct design installation recommendations, see the Thermal Ceramics' complete installation guide.
 - a. Installation shall be performed by an experienced contractor per manufacturer instructions, applicable UL Listings and ICC-ES building code report (ESR 2213 or ESR 2832). Provide UL Listed liquid tight Thermal Ceramics FastDoor XL access doors where required by code. Sheet metal and insulation contractors shall coordinate installation of FastDoor XL.
2. Install 2 layers of Firewrap for a 2-hour commercial kitchen grease duct application per ASTM E 2336.
 - a. General Installation Instructions for Double Layer Installations: The inside layer of Firewrap blankets are cut to a length that will fit around the duct and meet with a tight butt joint. Adjacent blankets on the inside layer are tightly butted against each other. The outside layer is cut to a length that will fit around the duct and overlap itself no less than 3 inches (152 mm). Adjacent blankets on the outside layer overlap each other a minimum of 3", or they can be fitted together with a tight butt joint and covered with a 6-inch (305 mm) wide collar centered over the butt joint. Cut edges of the blanket shall be taped with aluminum foil tape to prevent exposed edges of the insulation from wicking of condensation moisture in air ventilation ducts or grease from a leaking grease duct joint. During installation the blankets are temporarily held in place with filament tape until the wrap is mechanically attached with steel bands or steel insulation pins.
3. Mechanical Fastening of Enclosure Material to Ductwork:
 - a. Banding - Carbon steel or stainless steel banding is used to hold the outer layer of the blanket enclosure in place. Banding is minimum 1/2 inch (12.7 mm) wide and is placed around the entire perimeter of the duct on maximum 10-1/2 inches (267 mm) centers and 1-1/2 inches (38 mm) from each blanket or collar edge.
 - b. Pinning - To prevent blanket sag on duct spans 24-inch wide (610 mm) or larger, minimum 12-gauge steel insulation pins are welded to the duct along bottom horizontal and outside vertical runs in columns spaced 12 inches (305 mm) apart, 6 to 12-inch (152 to 305 mm) from each edge and on 10-1/2 inches (267 mm) centers. Pins are also required 1 inch (25 mm) from the end of a duct and 1 inch (25 mm) from any edge near a 90° bend spaced 6-inch (152 mm) apart. Pins are locked in place with 1-1/2 inch (38 mm) diameter or 1-1/2 inch (38 mm) square galvanized steel speed clips or cup head pins. Pins are turned down or the excess cut off to eliminate sharp edges.

4. Grease Duct Access Door Installation:
 - a. Install field fabricated doors per manufacturers' instructions and applicable building code reports and laboratory design listings.
 - b. Prefabricated DuctMate F2-HT or DuctMate Ultimate doors may be installed per manufacturers' installation instructions and field insulated per Thermal Ceramics installation instructions, applicable building code reports and laboratory design listings.
 - c. Install access openings at each change in direction and at intervals as required by code. Insulation cover system shall be tested and listed by UL (HNKT G18) to provide zero clearance to combustible construction and 2-hour fire rating per ASTM E 2336. Duct access cover panel shall be tested and listed by UL (YYXS.MH47995) with integral neoprene gasket to provide liquid tight seal and shall have a high temperature gasket and signage "Access Door – Do Not Obstruct" compliant to code and NFPA 96. Installation shall be performed by an experienced contractor per manufacturer instructions and applicable UL Listings. Sheet metal and insulation contractors shall coordinate installation of the FastDoor XL and the duct enclosure system.

5. Through-Penetration Firestop System:
 - a. When the duct penetrates a concrete or dry wall fire rated floor, ceiling, or wall an approved firestop system shall be employed. Firewrap shall be installed directly to the duct through the penetration, or terminated on both sides of the penetration depending on the annular space allowance between the duct and the duct opening. When the Firewrap enclosure system is terminated on both sides of the through penetration, the duct wrap material is mechanically attached to the duct at the termination points using either steel banding or steel pins.
 - b. To fire stop the through penetration void area, fill the annular space between the wrapped duct or bare duct and the periphery of the opening with scrap Firewrap firmly packed into the opening. Compress scrap blanket to percentage stated in the firestop listing for a minimum depth as specified in the firestop listing. Recess packing material below surface on both sides of walls or top side only for floors to the depth stated in the firestop listing. Seal over the packing material using an approved firestop sealant to a depth as stated in the firestop listing, flush with top side of a floor assembly and both sides of a wall assembly.

E. Repair Procedures:

1. Repair damaged Firewrap in accordance with manufacturer's instructions.
2. Remove damaged section by cutting the bands and removing the anchor clips holding it in place. Apply a new section of the same dimension ensuring the same overlap and installation method that existed previously. Cut edges and tears in the foil must be taped with aluminum tape to prevent the insulation from wicking moisture or grease.

F. Protection:

1. Protect installed products until completion of project.

2. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 230700

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SECTION 230800 - COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 230100, "Mechanical General Provisions," and Section 265100, "Interior Building Lighting" apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 WORK INCLUDED

- A. A separate Commissioning Agent (the Architect/Engineer) will be engaged by the Owner to administer the commissioning.
- B. The Contractor shall provide all commissioning services as outlined in this Section; perform all testing, measurements, and inspection outlined in the "Commissioning Plan"; and coordinate with the Commissioning Agent. A template Commissioning Plan is attached. The final plan will be written after the construction contract is underway.
- C. The Systems to be commissioned include:

All HVAC and related systems.
 - 1. Domestic water heating
 - 2. All lighting

1.3 COMMISSIONING OBJECTIVES

- A. To ensure that all building systems, subsystems, equipment, controls, and interfaces with other building systems are installed, tested, and are operating in compliance with Contract Documents and within the scope of design requirements.
- B. To ensure that all system operation and maintenance personnel are properly instructed to effectively and efficiently operate and maintain the systems, subsystems, equipment, and controls, and that they will receive all required manuals and documentation.
- C. The Commissioning Agent shall provide the following to the Contractor for implementation and execution.

1. Commissioning Plan: The Commissioning Agent shall prepare the Commissioning Plan in accordance with contents as specified herein.
2. Checklists and Test Forms: The Commissioning Agent shall prepare the Pre-Functional Checklists and Functional Performance Test Forms, specifically for this project, and edited to suit the equipment and systems installed.
3. Submittals:
 - a. The Contractor shall submit the following documents to the Commissioning Agent for review and inclusion in the Commissioning Plan.
 - i. Piping pressure and vacuum test reports
 - ii. Equipment startup reports
 - iii. DALT report
 - iv. TABs report
 - v. HVAC Water quality test report
 - vi. Prefunctional Checklists completed by the installing Foreman.
 - vii. Functional Checklists completed by the Mechanical Contractor.
 - viii. O&M Manuals with warranties
 - ix. Training class agenda and schedule
 - b. Commissioning Report: The Commissioning Agent shall assemble the final Commissioning Report comprised of completed prefunctional and functional checklists, equipment startup test reports, etc. organized by subsystem and submitted as one package. The results of failed tests shall be included along with a description of the corrective action taken.

1.4 REFERENCED STANDARDS

- A. ASHRAE 90.1-2016, 6.7.2.4
- B. NEBB, "Procedural Standards for Building Systems Commissioning."
- C. SMACNA, "HVAC Systems Commissioning Manual."

1.5 COMMISSIONING TEAM

- A. The Contractor shall designate team members from each of the following to participate in the Commissioning Process (both pre- and post-occupancy):
 1. General Contractor
 2. Mechanical Subcontractor (and HVAC startup technicians)
 3. Electrical Subcontractor
 4. Testing, Adjusting and Balancing (TAB) Subcontractor
 5. Automatic Temperature Controls Subcontractor
- B. The Owner shall designate a representative to participate in the Commissioning Process.

- C. Each of the team member's names shall be submitted in writing to the Commissioning Agent for inclusion in the Commissioning Plan.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 IMPLEMENTATION OF COMMISSIONING PLAN

- A. Plan Submittal: After the start of construction, the Commissioning Agent shall provide the Commissioning Plan to the Contractor for implementation and execution. The Plan shall provide the scope of commissioning tasks to the appropriate parties. Typical elements of the Plan shall include the following:

1. Commissioning Agent's preparation of the Commissioning Test Schedule and distribution to the Contractor and Owner.
2. Commissioning Agent visits to the job site to observe installation activities.
3. Contractor's pre-startup verification and completion of the Pre-functional Checklists.
4. Contractor's submittal of equipment and systems startup verification to the Commissioning Agent.
5. Contractor's submittal of testing, adjusting, and balancing (TAB) reports to the Commissioning Agent.
6. Contractor's independent functional performance testing after receiving functional performance checklists from the Commissioning Agent.
7. Contractor's functional performance testing with the Commissioning Agent.
8. Contractor's completion of operating and maintenance manuals and submittal to the Commissioning Agent.
9. Contractor's operation and maintenance personnel instruction.
10. Commissioning Agent's preparation of the Final Commissioning Report and submission to Owner.
11. Owner acceptance

- B. Equipment and Systems Startup:

1. Pre-startup Verification: Prior to startup of equipment and systems, the Contractor shall indicate on the pre-start checklists and Commissioning Agent shall observe and verify that all items have been substantially installed in accordance with the project Contract Documents, including all change orders. Verification of the basic installation testing of systems shall be performed by the Contractor and shall include:
 - a. Hydrostatic testing of hydronic piping systems
 - b. Cleaning, flushing, and venting of piping systems, including removal and cleaning of all strainers
 - c. Cleaning of equipment and systems of construction dirt and debris, including replacement of filters, and all items per the approved checklists

- d. Lighting shop drawings, floor plans, and sequence of operations have been approved.
2. Startup Verification: The Contractor shall indicate on the startup checklists, and Commissioning Agent shall verify that all HVAC equipment, systems, and subsystems have been activated and operate substantially in accordance with Contract Documents, with all equipment, system, and electrical operating and safety devices checked and functional. The Contractor's work also includes but is not limited to:
 - a. Calibration and testing of all automatic temperature control devices and building automation systems.
 - b. Testing and verification of all interlocks and interfacing between HVAC equipment, systems, subsystems, and other building systems.
 - c. Completion of testing, adjusting, and balancing (TAB) work, including the rechecking of 10% of the measurements.
 - d. Startup testing of the lighting systems.
3. Startup Documentation: Completed startup checklists shall be filled out by the Contractor after startup verification of each HVAC system, subsystem or each item of HVAC equipment. Startup checklists used by the Contractor Technicians shall be neat and typed using standard formats appropriate for the equipment. At the request of the Owner, Contractor shall provide trend data demonstrating equipment has been started and is operating within design parameters.
4. Contractor's Independent Functional Performance Testing: Prior to the functional performance testing with the Commissioning Agent onsite, the Commissioning Agent shall send all Functional Performance Checklists to the Contractor. The Contractor shall be responsible for performing all tests and verifications included in the Functional Performance Checklists. Upon completion of checklists for each piece of equipment, Contractor shall sign and return checklists to the Commissioning Agent.
5. Notification: The Commissioning Agent shall notify the Owner and Contractor when the startup verification has been completed, Contractor's independent functional performance testing has been completed, and the HVAC functional performance testing with the Commissioning Agent can be started.

3.2 FUNCTIONAL PERFORMANCE TESTING

- A. Purpose: Every item of equipment, all systems and subsystems, controls, and all related equipment shall be tested and evaluated for conformance to performance data in the Contract Documents. Included is conformance to:
 1. Equipment input and output capacities.
 2. Systems and subsystems flow and distribution performance.
 3. Control system performance, accuracy, and adherence to sequences of operation.
 4. Minimum or part load operations and performance.
 5. Interface with other equipment and/or systems.

- B. Equipment Testing: Equipment functional performance testing shall not begin until the following notification of completion has been given to the Owner by the Commissioning Agent.
1. Copies of the manufacturer's equipment start up reports are submitted to the Engineer for review and approval.
 2. Copies of the commissioning pre-start up and start up reports are submitted to the Engineer and Owner for review and approval.
 3. Testing and balancing report is submitted to and approved by the Engineer.
 4. Direct digital control graphic screen shots of all equipment are submitted for approval by Engineer and Commissioning Agent, showing each unit operating within design parameters and Owner-designated operating schedules. Screen shots must be visible to Owner on Owner's front-end workstation when submitted.
 5. Demonstrate through trend data successful operation of the HVAC systems for a period of not less than 2 weeks. Any alarms during this 14-day period will restart the 14-day run time, unless otherwise advised by Engineer or Commissioning Agent.
 6. Functional performance test checklists developed by the Commissioning Agent shall be used by the Contractor to document the equipment functional performance tests. Each item of equipment will be functional performance tested by the Contractor and the results documented by the Contractor at full load (and under part load conditions where required by the Contract Documents). Operation under "abnormal and/or emergency conditions" shall be simulated by the Contractor for equipment and systems, and all safety equipment and control operations verified. Test methods shall be documented and approved by the Commissioning Agent prior to implementation and shall be covered during the Owner's training as well. No equipment test functions or procedures shall be eliminated from the functional performance test unless approved by the Commissioning Agent and the Owner.
- C. Systems Testing: Functional performance testing shall not begin until all equipment and systems have had startup verification by the Contractor and notification of completion has been given to the Owner by the Commissioning Agent.
1. Functional performance test checklists to document system or subsystem functional performance tests.
 2. The functional performance testing of systems by the Contractor shall begin after equipment and subsystems have been tested and documented 14-day alarm free operation. The system interlock and interface testing sequence shall depend on the system design, complexity, and other factors.
 3. HVAC systems and subsystems shall be tested under full load conditions and under part load conditions by the Contractor.
 4. Actual physical responses shall be observed. Reliance on control signals or other indicators is not acceptable.
 5. Control component input and output signals shall be confirmed by the Contractor for correctness under all operating conditions.
 6. At the end of the functional performance test procedures, every mode of each operation of a system, each piece of equipment, every item in the control sequence description, and every zone or subsystem shall be proven to operate by the Contractor as defined in the project Contract Documents.

- D. Test Documentation: Functional performance test checklists developed by the Commissioning Agent shall be used by the Contractor to document the results of the functional performance testing process.
1. Testing verification shall be provided by signatures of responsible parties (the Contractor, Sub-Contractors, Commissioning Agent, and Owner's Representative) on the functional performance test checklists and equipment checklists.
 2. Functional performance testing shall be performed by the Contractor, by members of the Commissioning Team as outlined, and approved by the Commissioning Plan.
 3. All members shall remain on the Commissioning Team throughout the entire functional performance testing procedures. Substitutions shall be permitted only by written approval of the Commissioning Agent and Owner.
- E. Test Failures: No system or subsystem shall be accepted until all items of equipment in the system have approved and verified functional performance test checklists.
1. When a functional performance test is not approved, the Contractor shall be directed to provide a written report to the Commissioning Agent listing the deficiencies causing the test failure, and the possible remedies to correct the deficiencies.
 2. After all deficiencies have been corrected; the entire functional performance test for the equipment, system, or subsystem shall be repeated.
 3. The Commissioning Agent will continue to monitor the actions to correct the equipment or system deficiencies until an acceptable functional performance test has been accomplished.
- F. Deferred Tests: If any checklist or functional performance test cannot be completed for seasonal reasons, lack of occupancy, or for other reasons, a written report shall be sent by the Contractor to the Commissioning Agent indicating when the test will be scheduled.
1. If any checklist or functional performance test cannot be accomplished due to deficiencies outside the scope of the work, the deficiencies shall be resolved and corrected by the appropriate parties before completion of the commissioning process.
- G. Control System Verification: The Control Contractor shall provide a field technician on site with a portable control access computer and related test equipment. The date and time of this control system verification testing shall be scheduled in advance with the Commissioning Agent. The field technician shall demonstrate to the Commissioning Agent the accuracy of each physical input point, and the response of each physical output point during each mode of operation identified in the Sequence of Controls.
- H. A checklist shall be provided by the Contractor for each of the physical hardware points prior to this system verification demonstration, with all identification information and the physical location of each physical input/output device. For input sensors, this checklist shall be completed during the field test to indicate what the actual measured reading was during the verification, versus what the control system indicated it was. For output devices, this checklist shall indicate what the response actually was versus what it should have been for each mode of operation. Any defective control component shall be replaced, and any programming errors identified shall be corrected and re-demonstrated to the Commissioning Agent.

- I. Every item of the systems listed in 1.2.B shall be functionally tested in the presence of the Commissioning Agent and Owners Representative by installing contractor and supplying vendor technical representative.
- J. Upon completion of the Function Performance testing process as listed in the above items, Contractor shall submit electronic copies of project Operation & Maintenance manuals to Engineer and Commissioning Agent for review and approval.
- K. The lighting occupant sensors, lighting schedules, etc. shall be verified during functional testing in accordance with the International Energy Code.

3.3 OPERATOR INSTRUCTION

- A. During System Installation: Schedules and materials for the participation of the operation and maintenance personnel during the installation of the systems and equipment shall be implemented as per the Commissioning Plan or as indicated in the Contract Documents by the Contractor.
 - 1. Operation and maintenance personnel instruction shall include:
 - a. An instruction agenda with objectives
 - b. Classroom sessions using Contract Documents (specifications, system drawings), shop drawings, sequence of operations, equipment installation and operation manuals, and audio-visual aids, etc.
 - c. "Factory specialist" presentations by representatives approved by the Commissioning Agent
 - d. Job site visits
 - e. Sign-in sheets to verify attendance
 - f. Video-taping of all sessions
- B. During Commissioning: The Contractor shall prepare schedules and coordinate the training sessions with the parties involved.
 - 1. Equipment and systems maintenance manuals and schedules should be provided along with other information not provided during the installation phase instruction sessions.
- C. Turn-over Instruction: When the systems are ready to be turned over to the Owner, the Contractor shall schedule a final session for operation and maintenance personnel instruction. The following shall be included:
 - 1. Attendance by the Commissioning Agent, installing contractors, major equipment suppliers, and all other interested parties
 - 2. Review of all system and equipment operations
 - 3. Additional hands-on instruction where requested by the Owner or Commissioning Agent
 - 4. A question/answer discussion period

3.4 COMMISSIONING REPORT

- A. The commissioning documentation shall be prepared by the Commissioning Agent and shall be organized into a format similar to the Commissioning Plan. All pages shall be numbered, a table of contents provided, and shall include the following information:
1. Commissioning Plan: Provide a copy of the Commissioning Plan.
 2. TAB Reports: Contractor shall provide approved testing, adjusting, and balancing (TAB) reports for all HVAC systems being commissioned to the Commissioning Agent for inclusion in the Report.
 3. Drawings: As-built shop drawings of equipment and systems, sequence of operations, and as-built Contract Documents as modified by change orders shall be provided by the Contractor to the Commissioning Agent for inclusion in the Report.
 4. Startup Checklists: Provide all startup checklists and equipment startup reports, organized by systems and subsystems.
 5. Functional Performance Tests: Functional performance test checklists for all equipment, systems, subsystems, interlocks, and system interfaces organized by systems and subsystems shall be provided by the Contractor to the Commissioning Agent for inclusion in the Report.
 6. Operation and Maintenance Manuals: Copies of approved operation and maintenance manuals specified in the systems Contract Documents and/or in the Commissioning Plan shall be provided by the Contractor to the Commissioning Agent for inclusion in the Report.
 7. Video-Tape: Copies as indicated in the Contract Documents shall be provided by the Contractor to the Commissioning Agent for inclusion in the Report.

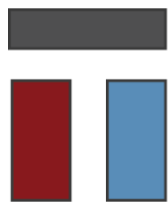
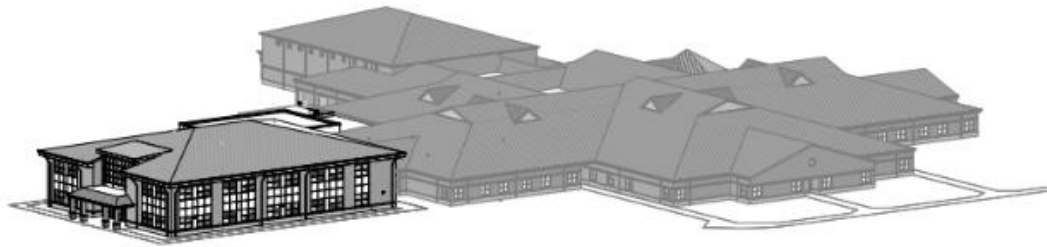
3.5 ACCEPTANCE

- A. Documents to Owner: The Commissioning Agent shall be responsible for maintaining the commissioning documentation until Final Acceptance of the project. All checklists required by this Section shall become part of the commissioning documentation. The commissioning documentation shall be kept current and shall always be available for inspection. At the time of final acceptance of the project, the Commissioning Agent shall furnish one hard copy and one electronic copy (located on a USB thumb drive) of the commissioning documentation to the Owner.
- B. Warranties: All equipment and system guarantees and warranties specified in the Contract Documents shall be furnished to the Owner by the Contractor at the time of final acceptance of the project.

END OF SECTION 230800

COMMISSIONING PLAN

NORTHERN SHORES ELEMENTARY SCHOOL ADDITION



THOMPSON
CONSULTING ENGINEERS

Project No. 24-053

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COMMISSIONING OVERVIEW

The purpose of this Commissioning Plan is to provide a clear and concise roadmap for the implementation of the commissioning process. The systems to be commissioned are identified in the Project Specifications.

This Commissioning Plan is a living document. The basic process and procedures for commissioning this project are detailed below. As the project develops appendices will be added to organize test reports, startup technician reports, issues logs, and completed checklists. Test documentation will be added throughout the construction project. At the end of the project the resulting compilation of information will become the Final Commissioning Report.

Integrating commissioning into a fast-moving construction project can be a challenge. The points below describe how our firm performs Commissioning.

- Commissioning begins during the design stage when our Commissioning Agent (CxA) reviews the project documents and makes comments to the designers. A Commissioning Plan is prepared for inclusion in the Bid Documents.
- After the construction contract is awarded and prior to the start of system rough-in, a Kick Off Meeting is held with the construction team. This will include the Project Managers and Foremen for the General, Mechanical, Electrical, TABs, and Controls Contractors; Equipment Representatives; and the Owner.
- The General Contractor (GC) is asked to maintain the Prefunctional Checklist. This document is a part of the Commissioning Plan and has a checklist for every unit on the drawing HVAC equipment schedule. The installing trade Foreman is asked to review the Prefunctional Checklist and confirm completion by initialing each item. When the Prefunctional Checklist is complete, the GC requests a CxA site visit.
- The GC is requested to not start HVAC equipment until receiving concurrence from the Engineer, CxA and Owner. Prior to granting concurrence, the CxA will confirm the Prefunctional Checklist is complete and discuss the building conditions with the GC. The goal being to prevent permanent damage to the equipment.
- Equipment startup is required to be performed by Factory Authorized technicians and documented on standardized report forms.
- After startup, the Test and Balance Contractor (TABs) may begin his work.
- The Design Engineer and CxA will review all startup and testing, adjusting, and balancing (TABs) reports.

- When the TABs report has been submitted and approved by the Design Engineer and the control system is complete; Functional Commissioning may begin.
- Functional Testing will include all specified modes of control and sequence of operation under full and part load. The performance of alarms will be checked.
- Typically, Functional Commissioning occurs between Substantial and Final Completion of the Project. As such, design weather conditions may not be available when the project has achieved Substantial Completion. To address this issue, we follow the following guidelines.
 - Refrigerant based systems which reject heat to the atmosphere can be properly verified only when near design conditions are present. For these systems, second season testing is sometimes required.
 - Gas and electric heating sources and geothermal water source heat pumps can typically be verified by measuring the temperature differential across the appliance. For cases when this is not possible, second season commissioning will be performed.
 - Equipment shall not be forced to operate in the cooling or heating mode other than through the raising or lowering of coil discharge or indoor space temperature setpoints.
 - If there is insufficient time to perform the functional testing during the construction period, seasonal commissioning may have to be performed the following year.
 - When the building must be occupied prior to Functional Commissioning, the testing occurs after normal hours for the occupants.
- The Engineer shall review all as-built record drawings, control drawings, and sequences of operation. Any changes to the electrical design to accommodate a substitute piece of equipment shall be reflected in the Record Drawings.
- The CxA or another member of Thompson Consulting Engineers will review the O&M manuals and Training Agenda.
- A Final Commissioning Report will be prepared and issued by the CxA along with a recommendation on Final Acceptance after all the Issues Log items have been resolved.

DESIGN PHASE

During the design phase, the CxA performs the following activities:

- Review and Modify Project Specifications
- Develop Initial Commissioning Plan
- Attend Pre-Bid Meeting (if requested)

Review and Modify Project Specifications

There are specific commissioning requirements located throughout the project specifications. During design, the CxA will review the specifications and suggest changes to the Design Engineer.

The specifications include the format in which contractor submittals will be presented, pressure testing of piping and duct systems, startup requirements, training requirements, system manual requirements, and so on.

The CxA will include the quality related items from the specifications in the commissioning checklists.

Develop Initial Commissioning Plan

The initial commissioning plan is similar to many other projects. It is intended to clarify individual roles and responsibilities relative to the commissioning process, identify the systems to be commissioned, and include a few typical commissioning checklists.

The commissioning plan will be distributed as a part of the project specifications.

Attend Pre-Bid Meeting

A representative of Thompson Consulting Engineering will attend the Pre-Bid Meeting, if requested.

CONSTRUCTION PHASE

During construction phase, the CxA tasks include:

- Attend the Pre-Construction Meeting (if requested).
- Conduct the Commissioning Kickoff Meeting.
- Back check Prefunctional Checklists maintained by the Installing Contractors.
- Monitor system startup
- Maintain and distribute the Issues Log.
- Conduct Functional Testing.
- Review the Owner Training Agenda.
- Review the Operation and Maintenance (O&M) manual.

Pre-Construction Meeting

Once the contractor is selected, the commissioning authority will attend and participate in the pre-construction meeting if requested. The role of CxA during the meeting will be to review and discuss the commissioning and the communication protocols the project team has developed.

Commissioning Kickoff Meeting

Prior to the start of Pre-Functional testing, the CxA will lead a kickoff meeting. This will include the Project Managers and Foremen for the General, Mechanical, Electrical, TABs, and Controls Contractors; Equipment Representatives; and the Owner.

The meeting will review the goals of commissioning, establish a schedule, and assign responsibilities to specific individuals. Once an individual is assigned to be a part of the commissioning team, they cannot be removed without prior concurrence of the commissioning authority to preserve continuity.

Prefunctional Checklists

The Prefunctional Checklists are developed by the commissioning authority. They are to be completed by the General Contractor and Subcontractors. The intent of the checklists is to provide an organized method to verify the equipment is properly installed and requirements of the Project Documents are met.

System Startup

When the Prefunctional Checklists are complete, and the building cleanliness is adequate, equipment startup can proceed. The specifications contain specific requirements for startup. A field report for each unit is required to be submitted for review and inclusion in the final commissioning report.

Issues Log

The CxA will maintain an Issues Log to track items of concern. Each item will stay open until it is resolved; either by correcting the construction, demonstrating compliance as-is; or Owner acceptance.

Functional Testing

Functional testing occurs after all construction and startup is complete, the TABs report is approved by the Engineer, and DDC graphics are finished. A small team consisting of the CxA, Controls Technician, Mechanical Contractor, Equipment Startup Technicians, TABs Agent, and Owners Representative will exercise all the systems in the project scope.

Review Training

The CxA will review the contractor's submitted training agenda to ensure the specification requirements are covered and the contractor understands the expectations of training.

O&M Systems Manual

The Construction Administrator or the CxA will review the final manual for completeness and clarity.

Warranty Review

The Construction Administrator or CxA will review the warranty certificates provided by the Contractor.

CONTACT INFORMATION

Owners Representative

[OWNER PM AND TITLE]
[DEPARTMENT AND JURISDICTION]
[ADDRESS 1]
[ADDRESS 2]
[CONTACT #]

Architect

[ARCHITECT PM AND TITLE]
[ARCHITECT FIRM]
[ADDRESS 1]
[ADDRESS 2]
[CONTACT #]

Mechanical Engineer

Kevin Allen, P.E.
Thompson Consulting Engineers
22 Enterprise Parkway, Suite 120
Hampton, VA 23666
(757) 599-4415

General Contractor

TO BE DETERMINED

Mechanical Contractor

TO BE DETERMINED

Controls Contractor

TO BE DETERMINED

TABs Contractor

TO BE DETERMINED

SECTION 230900 - AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 230100, "Mechanical General Provisions," apply to this Section.
- B. Refer to Drawings for "Sequences of Operation" for unit control sequences.
- C. **Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.**

1.2 SCOPE

- A. The BAS/ATC (Building Automation System/Automatic Temperature Control) systems as specified herein shall be provided in their entirety by the BAS/ATC Contractor. The BAS/ATC Contractor shall base his Bid on the system as specified, the sequence of operations, the points list, and Contract Documents. Regardless of the points listed in these documents, the Contractor shall provide the number of points, the types of points, and other controls as required for the sequence of operations.
- B. It shall be the responsibility of the BAS/ATC Contractor to fully coordinate with all equipment suppliers, and with the fire alarm system designer/installer to provide a complete functional control system.
- C. All Direct Digital Controllers shall be factory mounted, programmed, and commissioned. Where factory mounting, programming, or commissioning is not possible, it shall be the responsibility of BAS/ATC Contractor to provide, at time of submittal, a detailed Commissioning Plan as specified in "COMMISSIONING" Section 3.13. It shall be the responsibility of the Mechanical Equipment Supplier and the ATC Contractor to ensure that the entire system (Mechanical Equipment and Automatic Temperature Controls) be free of defects and function as specified. Any control devices required by the "Mechanical General Provisions" specification or the "Automatic Temperature Control" specification shall be furnished without any additional cost to Owner.

1.3 SUBMITTALS

- A. The following data/information shall be submitted for approval in conjunction with the Mechanical Equipment Submittal (separate Control and Equipment submittals will be rejected):

1. Complete sequence of operation.
2. Provide a detailed commissioning procedure as specified in "COMMISSIONING" Section of this specification.
3. Control system CAD-generated drawings, including all pertinent data to provide a functional operating system.
4. Damper schedules of all control dampers including damper size, manufacturer, and model number.
5. Data sheets for all hardware and software control components.
6. A description of the installation materials, including conduit, wire, flex, etc.
7. Computer panel locations.
8. Provide as part of the submittal eight copies of all data and control drawings.

1.4 QUALIFICATIONS

- A. The BAS/ATC Contractor shall be the local office of a nationally recognized organization within a 75-mile radius of the job site. This office shall be staffed with four (4) factory trained engineers and four (4) factory trained service technicians fully capable of providing instruction, routine maintenance and 24-hour emergency maintenance service on all system components. The ATC Contractor shall have a 5-year experience record in the design and installation of computerized building systems similar in scope and performance to that specified herein, and shall provide evidence of this history as condition of acceptance. **The DDC system shall be an extension of the Campus wide TRANE SUMMIT DDC System. No other manufacturers are acceptable.**

PART 2 - PRODUCTS

2.1 MATERIAL

- A. All materials and equipment used shall be standard components, of regular manufacture for this application. All systems and components shall have been thoroughly tested and proven in actual use. The commissioning requirements of this specification shall be strictly adhered to.

2.2 GENERAL

- A. Building Automation System shall include but not be limited to the following components.
 1. The Operator Interface shall consist of hardware and software that allows full user monitoring and adjustment of system parameters.
 2. Building Control Unit (BCU) shall manage the Energy and Building Management capabilities of the automation system as well as facilitate remote communications and central monitoring.

3. The Data Communications capability shall allow data to be shared between the various controllers in the architecture.
4. The system software shall include software for global application functions, application software for distributed controllers, and operator interface software.
5. End devices such as sensors, actuators, dampers and relays.
6. The failure of any single component shall not interrupt the control strategies of other operational devices. System expansion shall be through the addition of end devices, controllers, and other devices described in this specification.
7. Communication between the control panels and all workstations shall be over a high-speed network. All nodes on this network shall be peers. The operator shall not have to know the panel identifier or location to view or control an object. Application Specific Controllers shall be constantly scanned by the network controllers to update point information and alarm information.

2.3 WEB SERVER OPERATOR INTERFACE

- A. Upgrade automation server software to current version at substantial completion and fully interface with the existing graphic driven enterprise web server at no additional cost to the Owner.

2.4 WEB SERVER / ENTERPRISE SYSTEM OPERATOR INTERFACE

- A. Enterprise System shall be a web-enabled service and monitoring tool that can support multiple individual systems. Enterprise System shall integrate building systems into a cohesive enterprise-wide system using open standards, through communication over BACnet/IP networks. Building operators and administrators shall have the ability to access the web server from the local network or internet to monitor and control the building system.
- B. Central Server Components:
 1. The central server shall consist of the following (minimum):
 - a. System shall utilize a server class PC, tower or rack mounted
 - b. Two Xeon 2.8GHz, 1MB L3 cache processors
 - c. 2GB, DDR266 SDRAM memory
 - d. DVD+R/W or CD ROM
 - e. Microsoft Windows Server 2008, IIS V7+
 - f. Microsoft SQL Server 2005
 - g. NET Framework 1.1 BJE: .NET 3.5
 - h. Furnish all require serial, parallel, and network communication ports, and all cables for proper system operation. The server shall include a minimum 17" color monitor with 1024 x 768 screen resolution.
- C. Furnish 2 laptops based for operator interface. The Building Automation System supplier shall provide all cables, connectors, software, and hardware required to

monitor, modify, upload, and download all DDC Controllers furnished on the project. Each of these operator interfaces shall be able to access all information in the system. The operator interface shall reside on the Enterprise wide network, which is same high-speed communications network as the Building Controllers. The Enterprise wide network will be provided by the owner and supports the Internet Protocol (IP). Workstations shall be able to dial into the system.

1. Each PC based operator interface shall include the following:
 - a. Operating System: Latest Windows operating system at bid date.
 - b. Minimum Hardware
 - 1) Core i5 DUO or better Core i5
 - 2) 4 GB RAM
 - 3) 100 GB hard drive space
 - 4) Internet Browser compatible with operator interface requirements outlined in the operator interface section
 - 5) Java Runtime Environment (JRE) V6.0 or higher
2. Operator Interface:
 - a. The operator interface shall be accessible via a web browser.
 - b. The operator interface shall support the following Internet web browsers:
 - 1) Internet Explorer 8.0+
 - 2) Firefox 18.0+

- D. Contractor shall upgrade automation server firmware and software to current version during the 2 year warranty period and fully interface with the existing graphic driven enterprise web server at no additional cost to the Owner. The BAS/ATC contractor shall provide 3 additional license seats.

2.5 ARCHITECTURE/COMMUNICATION

- A. This project shall be comprised of a high-speed Ethernet network utilizing BACnet/IP communications between System Controllers and Workstations. Communications between System Controllers and sub-networks of Custom Application Controllers and/or Application Specific Controllers shall utilize BACnet MSTP (RS485) communications.
1. The Owner will provide all communication media, connectors, repeaters, network switches, and routers necessary for the high-speed Ethernet network.
 2. All values within the system (i.e. schedules, data logs, points, software variables, custom program variables) shall be readable and controllable (where appropriate) by any System Controller or BACnet Workstation on the communications network via BACnet.

- a. System Controller specific: Each System Controller shall perform communications to a network of Custom Application and Application Specific Controllers using BACnet/MSTP (RS485) as defined by the BACnet or standard.
- b. Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all BACnet/MSTP controllers within the system.

2.6 BUILDING CONTROL UNIT APPLICATION AND CONTROL SOFTWARE

- A. Furnish the following applications software for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the operator interface.

- 1. Scheduling. Provide the capability to schedule each object or group of objects in the system. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to 10 events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:

- a. Weekly Schedule. Provide separate schedules for each day of the week.
- b. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it will be discarded and replaced by the standard schedule for that day of the week.
- c. Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
- d. Optimal Start. The scheduling application outlined above shall support an optimal start algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less than and greater than 24 hours. Provide the ability to modify the start algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.

- 2. Alarm/Event Log:

- a. Any object in the system shall be configurable to generate an alarm when transitioning in and out of a normal or fault state.

- b. Any object in the system shall allow the alarm limits, warning limits, states, and reactions to be configured for each object in the system.
- c. An alarm/event shall be capable of triggering any of the following actions:
 - 1) Route the alarm/event to one or more alarm log.
 - a) The alarm message shall include the name of the alarm location, the device that generated the alarm, and the alarm message itself.
 - 2) Route an e-mail message to an operator(s)
 - 3) Log a data point(s) for a period of time
 - 4) Run a custom control program
- 3. Point Control. User shall have the option to set the update interval, minimum on/off time, event notification, custom programming on change of events.
- 4. Timed Override. A standard application shall be utilized to enable/disable temperature control when a user selects on/cancel at the zone sensor, operator interface, or the local operator display. The amount of time that the override takes precedence will be selectable from the operator interface.
- 5. Anti-Short Cycling. All binary output points shall be protected from short cycling

2.7 BUILDING CONTROL UNIT CONTROLLERS

- A. There shall be one or more independent, standalone microprocessor based BCU Controllers to manage the global strategies described in Application and Control Software section.
 - 1. The System Controller shall have sufficient memory to support its operating system, database, and programming requirements.
 - 2. The controller shall provide a USB communications port for connection to a PC
 - 3. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 - 4. All System Controllers shall have a real-time clock.
 - 5. Data shall be shared between networked System Controllers.
 - 6. The System Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
 - a. Assume a predetermined failure mode.
 - b. Generate an alarm notification.
 - c. Create a retrievable file of the state of all applicable memory locations at the time of the failure.
 - d. Automatically reset the System Controller to return to a normal operating mode.

7. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at -40 F to 122 F.
 8. Clock Synchronization:
 - a. All System Controllers shall be able to synchronize with an NTP server for automatic time synchronization.
 - b. All System Controllers shall be able to accept a BACnet time synchronization command for automatic time synchronization.
 - c. All System Controllers shall automatically adjust for daylight savings time if applicable.
 9. Serviceability:
 - a. Provide diagnostic LEDs for power, communications, and processor.
 - b. The System Controller shall have a display on the main board that indicates the current operating mode of the controller.
 - c. All wiring connections shall be made to field removable, modular terminal connectors.
 - d. The System controller shall utilize standard DIN mounting methods for installation and replacement.
 10. Memory. The System Controller shall maintain all BIOS and programming information indefinitely without power to the System controller
 11. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage
 12. BACnet Test Labs (BTL) Listing. Each System Controller shall be listed as a Building Controller (B-BC) by the BACnet Test Labs.
- B. System Graphics:
1. Operator interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using colors to represent zone temperature relative to zone set point.
 - a. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point and-click navigation between zones or equipment, and to edit set points and other specified parameters.
 - b. Graphic Imagery. Graphics shall use 3D images for all standard and custom graphics. The only allowable exceptions will be photo images, maps, schematic drawings, and selected floor plans.
 - c. Animation. Graphics shall be able to animate by displaying different Image lies for changed object status.

- d. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
- e. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).

2. Custom Graphics:

- a. The operator interface shall be capable of displaying custom graphics in order to convey the status of the facility to its operators.
- b. Graphical Navigation. The operator interface shall provide dynamic color graphics of building areas, systems and equipment.
- c. Graphical Data Visualization. The operator interface shall support dynamic points including analog and binary values, dynamic text, static text, and animation files.
- d. Custom Background Images. Custom background images shall be created with the use of commonly available graphics packages such as Adobe Photoshop. The graphics generation package shall create and modify graphics that are saved in industry standard formats such as GIF and JPEG.

C. Service Tool:

- 1. Service Tool shall provide the necessary setup, configuration, and monitoring capabilities to service equipment/programmable controllers. Service Tool shall have the following capabilities:
 - a. Shall be capable of generating reports.
 - b. Shall be capable of assessing controller status, status of points and alarms.
 - c. Shall be capable of point configuration and overrides.
 - d. Shall be capable of scheduling controllers.
 - e. Shall be capable of creating backup and restore configuration files and settings.

2.8 DASHBOARDS

A. Dashboard-style Graphics:

- 1. Graphics in the form of dashboards that provide “at-a-glance” views of operation shall be provided for controlled systems and subsystems.
 - a. Dashboards shall be provided in addition to standard operator interface screens that can be used for advanced-level diagnostics and system configuration.

- b. Dashboards must allow, without any clicks, an operator to determine if the system depicted is operating as designed or if investigation is required.
 - c. Dashboards shall be customizable.
 - d. Dashboards shall reside in and be provided by enterprise-, system-, or equipment-level devices that are part of the automation system.
- 2. System dashboards shall allow end users to continuously view, monitor, and track “at-a-glance” conditions in end user identified critical areas.
 - a. Main dashboards shall depict representations of enterprise- or campus-level systems using maps and facility-level systems using external views of buildings. Main dashboards shall also depict system-level status for major areas using [color indications] and provide notice of and access to active and critical alarms.
 - b. Building or area dashboards shall indicate location represented within the overall system with simple shapes and color variations. Status of critical systems within the building or area as defined by end user shall be represented using simple icons, shapes, and colors.
 - c. Area or room dashboards shall indicate location represented within the building or area with simple shapes and color variations. Key parameters as defined by end user shall be depicted using gauges.
 - d. Representative dashboard examples shall be shown to owner for approval.
- 3. Equipment dashboards shall provide a summary of the equipment operating conditions.
 - a. Equipment dashboards shall depict operating conditions with a graphic representation of the equipment that utilizes animation.
 - b. Equipment dashboards shall utilize [gauges, charts, bars, status points] or other similar “at a glance” representations to depict critical operating conditions as defined by user.
- 4. Application dashboards shall provide a summary of the application conditions.
 - a. Application dashboards shall utilize [gauges, charts, bars, status points] or other similar “at a glance” representations to depict critical operating conditions as defined by user.
 - b. Application dashboards must depict the impact of system optimization strategies deployed.

2.9 EQUIPMENT CONTROLLERS

- A. Equipment Controllers shall be stand-alone, microprocessor based Direct Digital Controllers with sufficient memory to handle its operating system, a database, and programming requirements.

B. Architecture/Communication:

1. Equipment controllers shall meet the following communication requirements:
 - a. Communicate to System Controller via BACnet MS/TP.
 - b. To ensure integration to the installed system and additions the Controller must be BTL Testing Lab listed for the following: Advance Applications Controller (B-AAC).
 - c. To allow maximum communications speed and co-existence with other controllers the Controller shall support at a minimum the following BACnet MS/TP master baud rate: 9600, 19200, 38400, 76800.
 - d. In case of communications failure stand-alone operation shall use default values or last values for remote sensors read over the network such as outdoor air temperature.
 - e. In the event of communication failure, the Controller shall operate independently until communication is reestablished.

C. For Operation of the Equipment Controllers:

1. Shall operate a schedule in a standalone application using a Real Time Clock with a 7-day power backup.
2. For ease of troubleshooting, the Controller shall support data trend logging.
 - a. 25,000 samples minimum
 - b. Trends shall be capable of being collected at a minimum sample rate of once every second
 - c. Trends shall be capable of being scheduled or triggered.
3. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.
 - a. Storage conditions:
 - 1) Temperature: -67°F to 203°F
 - 2) Humidity: Between 5% to 100% RH (non-condensing)
 - b. Operating conditions:
 - 1) Temperature: -40°F to 158°F
 - 2) Humidity: Between 5% to 100% RH (non-condensing)
 - c. Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum.
 - d. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40 F to 158 F.

4. Input/Output: The Controller shall have on board or through expansion module all I/O capable of performing all functionality needed for the application. Controls provided by the equipment manufacture must supply the required I/O for the equipment. In addition, other controls must meet the following requirements:
 - a. Shall support flexibility in valve type, the controllers shall be capable of supporting the following valve control types 0-10VDC, 0-5VDC, 4-20mA, 24VAC - 2 position.
 - b. Shall support flexibility in sensor type, the Controller shall be of reading sensor input ranges of 0 to10V, 0 to 20mA, 50ms or longer pulses, 200 to 20Kohm and RTD input.
 - c. Shall support flexibility in sensor type, all Analog Outputs shall have the additional capability of being programmed to operate as Universal Inputs or Pulse Width Modulation Outputs.
 - d. Shall support flexibility in sensor type, the Controller and/or expansion modules shall support dry and wetted (24VAC) binary inputs.
 - e. The controller support pulse accumulator for connecting devices like energy meters.
 - f. In order to support a wide range of devices, the Controller's binary output shall be able to drive at least 10VA each.
 - g. Any I/O that is unused by functionality needed for the equipment shall be available to be used by custom program on the Controller and by any other controller on the network.
 - h. The Controller shall provide 24VAC and 24VDC power terminals sensors and other devices required.
 - i. The Controller shall provide a dedicated static pressure input.
5. Input/Output Expandability – The Controller shall provide the following functionality in order to meet current and future application needs:
 - a. For the application flexibility, the Controller shall be capable of expanding to a total of at least 100 hardware I/O terminations.
 - b. Expansion I/O can be mounted up to 200m from control
 - c. Expansion I/O can be added in as small as 4-point increments.
 - d. To keep BACnet MS/TP network traffic to a minimum, expansion I/O must communicate via an internal controller communication bus (point expansion via the BACnet MS/TP network is not allowed).
6. Serviceability – The Controller shall provide the following in order to improve serviceability of the Controller.
 - a. Diagnostic LEDs for power/normal operation/status, BACnet communications, sensor bus communications, and binary outputs. All wiring connections shall be clearly labeled and made to be field removable.
 - b. Binary and analog inputs and outputs shall use removable connectors or be connected to terminal strip external to the control box

- c. Software service tool connection through all of the following methods: direct cable connection to the Controller, connection through another controller on BACnet link and through the Controller's zone sensor.
 - d. For configuration, programming, and testing of controller programs must, for safety purposes, be able to be accomplished with the power off to the equipment and the controller.
 - e. The Controller software tool service port shall utilize standard off-the-shelf USB printer cable.
 - f. Capabilities to temporarily override the BACnet point values with built-in time expiration in the Controller.
 - g. To aid in service replacement, the Controller shall easily attached to standard DIN rail mounting.
 - h. For future expansion, the Controller shall be capable of adding sequence of operation programming utilizing service tools software with a graphical programming interface (editing or programming in line code is not permissible).
 - i. To aid in service replacement, the Controller shall allow for setting its BACnet address must be rotary switches that correspond to a numerical value for the address to allow the setting of the address without the need of a service tool or the control being powered (DIP switch methodologies are not allowed).
 - j. Controller data shall persist through a power failure.
7. Transformer for the Controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads for a maximum of 12 VA for each binary output.

2.10 ZONE CONTROLLERS

- A. Zone Controllers shall meet the following communication requirements:
- 1. To allow maximum communications speed and co-existence with other controllers, the controller shall support at a minimum the following BACnet MS/TP master baud rate: 9600, 19200, 38400, 76800, and 115200.
 - 2. To ensure integration to the installed system and additions the controller must be BTL Testing Lab listed for the following:
 - a. Advance Applications Controller (B-AAC) or
 - b. Application Specific Controller (B-ASC) and Supports sending alarm/event notifications to a subscriber.
- B. Application Specific Controllers (ASC) shall be microprocessor-based DDC controllers which through hardware or firmware design control specified equipment. They are not user programmable, but are customized for operation within the confines of the equipment they are designed to serve.

1. Application Specific Controller are only allowed when both the following:
 - a. The equipment is compressor based and
 - b. The controller is provided by the equipment manufacturer and warrantied as part of the equipment.
- C. Zone Controllers are controllers that operate equipment that control the space temperature of single zone. Examples are controllers for VAV terminal units.
 1. Software:
 - a. To meet the sequence of operation for each zone control, the controller shall use programs developed and tested by the controller manufacturer that are either factory loaded or downloaded with service tool to the controller.
 - b. Stand-Alone Operation: Each piece of equipment specified in section A shall be controlled by a single controller and provide stand-alone control in the event of communication failure. In case of communications failure stand-alone operation shall use default values or last values for remote sensors read over the network such as outdoor air temperature.
 - c. For controlling ancillary devices and for flexibility to change to sequence of operation in the future, the controller shall be capable running custom programs written in a graphical programming language.
 2. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
 - a. Storage: -55 to 203 °F and 5 to 95% Rh, non-condensing.
 - b. Operating: -40 to 158 °F and 5 to 95% Rh, non-condensing.
 - c. Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum
 - d. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40 F to 158 F.
 3. Input/Output:
 - a. For flexibility in selection and replacement of valves, the controllers shall be capable of supporting all of the following valve control types 0-10VDC, 0-5VDC, 4-20mA, 24VAC floating point, 24VAC - 2 position (Normally Open or Normally Closed).
 - b. For flexibility in selection and replacement of sensors, the controllers shall be capable of reading sensor input ranges of 0 to10V, 0 to 20mA, pulse counts, and 200 to 20Kohm.
 - c. For flexibility in selection and replacement of binary sensors, the controller shall support dry and wetted (24VAC) binary inputs.
 - d. For flexibility in selection and replacement devices, the controllers shall have binary output which are able to drive at least 12VA each.

- e. For flexibility in selection and replacement of motors, the controller shall be capable of outputting 24VAC (binary output), DC voltage (0 to 10VDC minimum range) and PWM (in the 80 to 100 Hz range).
 - f. For future needs, any I/O that is unused by functionality of equipment control shall be available to be used by custom program on the controller and by another controller on the network.
 - g. For future expansion and flexibility, the controller shall have either on board or through expansion, 20 hardware input/output points. Expansion points must communicate with the controller via an internal communications bus. Expansion points must be capable of being mounted up to 200 meters from the controller. Expansion points that require the BACnet network for communication with the controller are not allowed.
4. Serviceability – The controller shall provide the following in order to improve serviceability of the controller.
- a. Diagnostic LEDs shall indicate correct operation or failures/faults for all of the following: power, sensors, BACnet communications, and I/O communications bus.
 - b. All binary output shall have LED's indicating the output state.
 - c. All wiring connections shall removable without the use of a tool.
 - d. Software service tool connection through all of the following methods: direct cable connection to the controller, connection through another controller on BACnet link and through the controller's zone sensor.
 - e. For safety purposes, the controller shall be capable of being powered by a portable computer for the purposes of configuration, programming, and testing programs so that this work can be accomplished with the power off to the equipment.
 - f. Capabilities to temporarily override of BACnet point values with built-in time expiration in the controller.
 - g. BACnet Mack Address shall be set using decimal (0-9) based rotary switches.
 - h. Configuration change shall not be made in a programming environment, but rather by a configuration page utilizing dropdown list, check boxes, and numeric boxes.
 - i. BACnet trending objects resident on controller:
 - 1) Minimum of 20,000 trending points total on controller
 - 2) Shall be capable of trending all BACnet points used by controller
 - 3) Shall be capable of 1 second sample rates on all points
5. Software Retention: All Zone Controller operating parameters, set points, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.
6. Transformer for the controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/-

15% nominal, 50-60 Hz, 24 VA plus binary output loads, for a maximum of 12 VA for each binary output.

7. Agency Approval: The controller shall have meet the Agency Compliance:
 - a. UL916 PAZX, Open Energy Management Equipment
 - b. UL94-5V, Flammability
 - c. FCC Part 15, Subpart B, Class B Limit

2.11 AUXILIARY CONTROL DEVICES

- A. Motorized dampers, unless otherwise specified elsewhere, shall be as follows:
 1. Damper frames shall be 16-gauge galvanized sheet metal or 1/8" extruded aluminum with reinforced corner bracing.
 2. Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (2,000 fpm). Blades shall be not less than 16-gauge.
 3. Damper shaft bearings shall be as recommended by manufacturer for application.
 4. All blade edges and top and bottom of the frame shall be provided with compressible seals. Side seals shall be compressible stainless steel. The blade seals shall provide for a maximum leakage rate of 4 CFM per square foot at 1.0" w.c. differential pressure.
 5. All leakage testing and pressure ratings will be based on AMCA *Standard 511*.
 6. Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.
- B. Control dampers shall be parallel or opposed blade types.
- C. Differential Pressure Switches:
 1. Differential Pressure Switches shall be furnished as indicated for status purposes in air applications. Provide single pole single throw switch with fully adjustable differential pressure settings.
- D. Electric damper-actuators:
 1. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
 2. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.
 3. All rotary spring return actuators shall be capable of both clockwise and counter clockwise spring return operation. Linear actuators shall spring return to the retracted position.
 4. Proportional actuators shall accept a 0-10 VDC or 0-20 ma control signal and provide a 2-10 VDC or 4-20 ma operating range.

5. Actuators shall be provided with a conduit fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
6. Actuators shall be Underwriters Laboratories Standard 873 listed.

E. Fire Protection Devices:

1. Smoke detectors shall be furnished by Division 26 and installed by the Mechanical Contractor. Smoke detectors shall be wired to the fire alarm control panel. Provide interlock wiring to disable supply fan upon a detection of smoke.
2. Power wiring to the smoke detector and signal wiring from the smoke detector to the Fire Alarm Control Panel shall be furnished under Division 26. Unit shutdown wiring and control shall be the responsibility of the Automatic Temperature Controls Contractor.

F. Binary Temperature Devices:

1. Low-Voltage Space Thermostats shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed set point adjustment, 55°F-85°F set point range, 2°F maximum differential, and vented cover.
2. Line-Voltage Space Thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed set point adjustment, 55°F-85°F set point range, 2°F maximum differential, and vented cover.
3. Low-Limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 20 ft long. Element shall sense temperature in each 1 ft section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.

G. Temperature Sensors:

1. Temperature sensors shall be platinum Resistance Temperature Device (RTD) or 10,000 ohm Thermistor.
2. Duct sensors shall be rigid or averaging as shown. Averaging sensors shall be a minimum of 5 feet in length.
3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
4. Space sensors shall be equipped with set-point adjustment, override switch, and communication port as shown on the drawings.
5. Provide matched temperature sensors for differential temperature measurement. Differential accuracy shall be within 0.2 F.
6. Space sensor guards unless noted otherwise, provide **lockable** cast aluminum guards for sensors located in the gymnasium, and cafeteria. Provide lockable clear plastic guards in all public areas.

H. Humidity Sensors:

1. Duct and room sensors shall have a sensing range of 0% to 100% with accuracy of $\pm 3\%$ R.H.
 2. Duct sensors shall be provided with a sampling chamber.
 3. Outdoor air humidity sensors shall have a sensing range of 0% to 100% R.H. It shall be suitable for ambient conditions of -20 F to 140 F.
 4. Humidity sensor's drift shall not exceed 1% of full scale per year.
- I. Static Pressure Sensors:
1. Sensor shall have linear output signal. Zero and span shall be field-adjustable.
 2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.
- J. Relays:
1. Control relays shall be UL listed plug-in type with dust cover. Contact rating, configuration, and coil voltage suitable for application.
 2. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 Type enclosure when not installed in local control panel.
- K. Transformers and Power Supplies:
1. Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.
 2. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.
 3. Unit shall operate between 0 C and 50 C.
 4. Unit shall be UL recognized.
- L. Uninterruptable Power Source (UPS):
1. Provide UPS for all Building Control Units. UPS must be a minimum APC No. SUA1500 rated a 1440VA/980W and provide a minimum backup time of 20 minutes.
 - a. Mount UPS beside Building Control Units.
- M. Current Switches:

1. Current-operated switches shall be self-powered, solid state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.
- N. Pressure Transducers:
1. Transducer shall have linear output signal. Zero and span shall be field adjustable.
 2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.
- O. Local Control Panels:
1. All indoor control cabinets shall be fully enclosed NEMA 1 Type construction with hinged door, and removable sub-panels or electrical sub-assemblies.
 2. Interconnections between internal and face-mounted devices shall be pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600-volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
 3. Provide on/off power switch with over-current protection for control power sources to each local panel.

2.12 SECURITY SYSTEM

- A. User access shall be secured using individual security passwords for a minimum of eight users.
- B. Passwords shall have at least three levels of user access with data entry restrictions being assignable by password.
- C. User logon/logoff attempts shall be recorded.
- D. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.

2.13 ALARMS

- A. The Building Automation System shall provide audio, visual, contact closure, and remote e-mail annunciation for:
 1. Remote equipment failure
 2. Equipment run time
 3. Number of starts/stops
 4. Program failure

5. Card Failure
 6. Sensor Failure
- B. Each analog sensor and binary point shall be individually alarmed for values in excess of individual high/low limits or status.
- C. Dial-Up Communications: An AutoDial-up and auto-answer communications utility shall allow standalone Building Control Unit (BCU) to communicate with remote operator stations over voice grade phone lines.
- D. Remote Alarm/Reporting:
1. Controllers shall automatically e-mail operator stations to report alarms, and upload historical data and reports.
 2. In the event that the controller is unable to connect with the remote station, it shall continue to attempt communication on a predetermined interval until communication is successful. The capability shall exist to automatically switch to a backup e-mail in the event communications is unsuccessful.
- E. Remote Operator Communications:
1. Operators shall be able to dial up remote Building Control Unit (BCU) and gain access to the full control, reporting, and system modification capabilities described in this Specification.
 2. The operator shall dial up remote buildings from any laptop by selecting the user-definable name associated with the building. No extra databases shall be required to allow communication to BCU.

2.14 BUILDING MANAGEMENT SOFTWARE

- A. The following Building Management programs shall be furnished standard as part of the Building Automation System. The programs shall be enabled or disabled as directed by Owner.
1. Timed Override:
 - a. Timed override program shall be provided to enable the building operator to set up devices or groups of devices to be temporarily turned on for a defined period of time based on binary inputs or analog inputs.
 - b. The override time shall be adjustable from 1 to 720 minutes.
 - c. A standard weekly and monthly report shall be provided for easy documentation of timed override operation.
- B. Direct Digital Control:
1. The Direct Digital Control program shall allow modulating control of remote devices based on sensed data.
 2. Standard control strategies shall include proportional, proportional plus integral, and proportional plus integral plus derivative control.

3. Control routines shall be flexible enough to allow operator to set parameters and make adjustments.
4. Direct Digital Control loop setup and modification shall be done through pre-formatted edit screens, with parameters listed in English language.
5. Program shall include a dynamic graphic display printout routine to indicate the status and real-time performance of the control loop.
6. Custom Programming Language:
 - a. A custom control language capability shall be provided to allow the operator to create real time, equation based, custom control routines.
 - b. All binary and analog points in the Building Automation System shall be available as inputs to the custom routines.
 - c. Equation operations shall include math functions, such as addition, subtraction, multiplication, division, square root, minimum, maximum, and average. Logical functions such as greater than, less than, equal to, not equal to, less than or equal to, greater than or equal to, variable timing and delays shall also be allowed.
7. Run Time Maintenance:
 - a. The system shall monitor equipment status and generate maintenance messages based upon user designated run time, starts and/or calendar date limits.
 - b. A minimum of 32 separate devices shall be monitored under this function.
8. Expanded Messages: The user shall be able to define a minimum of ten 40-character messages for automatic printing in the event of system alarm and/or run time and maintenance events.
9. Reports and Logs: The system shall include the capability to store, review and print the following reports and logs. In addition, if a PC interface is specified, these reports shall be saved to diskette as an ASCII file for use by other Owner-furnished software packages.
 - a. Current Summary Report - An instantaneous summary of building status, including heating and cooling degree days, on and off peak electrical demand performance, current electrical kWh consumption, and summary for critical temperature sensors listing today's minimum and maximum values.
 - b. Monthly Summary Report - An end of the month summary of building status including heating and cooling degree days, on and off peak electrical demand performance, current electrical kWh consumption, and summary for critical temperature sensors listing this month's minimum and maximum values.
 - c. Monthly Demand Limiting Report - A report for logging the electrical demand performance (both on and off peak) and the kWh consumption for each of the two utility meter programs shall be provided to the building operator. Included shall be the times of today and yesterday's demand peaks as well as the time and date of

- the monthly demand peaks. This report shall log electrical performance for the present day and previous 32 days.
- d. Yearly Demand Limiting Report - A report for logging the electrical demand performance (both on and off peak) and kWh consumption for each of the two utility meter programs. This report shall log electrical performance for the present month and previous 12 months.
 - e. Yearly Meter Report - A report for logging the electrical kWh consumption for up to 6 sub meters. This report shall log electrical performance for the present month and previous 12 months.
 - f. Yearly Degree-Day Report - A current month and previous 12-month summary of heating and cooling degree-days.
 - g. Weekly Temperature Report - A previous 7-day summary of the minimum and maximum temperatures for the critical zone temperature sensors.
 - h. Weekly Override Time Report - A previous 7-day summary of after-hours override usage (in hours and minutes) for the timed override groups.
 - i. Monthly Override Time Report - A current and previous month summary of after-hours override usage (in hours and minutes) for the timed override groups).
 - j. Trend Logs - A custom report generator allowing the user to trend and store at least 24 sample points based on a user-defined schedule.
 - k. Event Logs - The system shall track system events including alarms, logons and diagnostics.
 - l. Input/Output Status Reports - This reporting tool shall allow the operator to review the status of all system points.
 - m. HVAC Equipment Reports - Reports shall be provided which indicate the HVAC equipment status as well as the status of all input/output points of connected HVAC equipment.
 - n. Custom Report Capability - The building operator shall be provided with a simple method of creating custom reports.

2.15 ANTI-RECYCLE TIMER PROTECTION

- A. A software program shall be provided to allow each individual piece of HVAC equipment to be individually programmable with “minimum on,” and “minimum off” timers to protect HVAC equipment from rapid cycling due to system or operator error.
- B. Minimum on/off timer program shall have priority over all application software functions except fire shutdown and smoke evacuation modes.
- C. For system start-up purposes, timers shall be set at 15 minutes of at an acceptable time as documented by the HVAC equipment supplier.
- D. Timers shall be individually programmable from 0 to 120 minutes.

2.16 CUSTOM PROGRAMMING REQUIREMENTS

- A. A user-friendly custom DDC programming utility shall be provided to allow the building operator to tailor the system to meet individual needs and respond to changing building requirements.
- B. The building operator shall be able to create custom DDC routines using analog and binary point values, alarm states, constants, and shared variables to perform calculations. The results of these calculations shall be used to perform analog control, binary control, DDC loop enable/disable, and other control functions.

PART 3 - EXECUTION

3.1 GENERAL

- A. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Design Build Contractor for resolution before rough-in work is started.
- B. The contractor shall inspect the site to verify that equipment is installable as shown, and any discrepancies, conflicts, or omissions shall be reported to the Design Build Contractor for resolution before rough-in work is started.

3.2 PROTECTION

- A. The Contractor shall protect all work and material from damage by his/her work or workers, and shall be liable for all damage thus caused.
- B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 GENERAL WORKMANSHIP

- A. Install equipment, piping, wiring/conduit parallel to System lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install all equipment in readily accessible location as defined by Chapter 1 Article 100 Part A of the NEC. Control panels shall be attached to structural walls unless

mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.

- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.4 FIELD QUALITY CONTROL

- A. All work, materials and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this Section.
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to System lines and properly supported.
- C. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

3.5 WIRING

- A. The Control Contractor shall provide all electrical control and interlock wiring required for the Automatic Temperature Control System furnished hereunder. All power wiring shall be furnished and installed per Division 26. Where electric power is supplied to a DDC Controller by this Contractor, a suitable circuit breaker will be furnished and installed by this Contractor.
- B. Controls Contractor shall provide all electrical and interlock wiring for the dishwasher exhaust fan and for proper operation of the commercial kitchen hood EMS with all system components, including but not limited to: Variable Frequency Drives (VFD), Exhaust Fans (EF), Make-up Air unit (MAU), heat sensors, control dampers and alarms.
- C. All electrical work performed under this Section shall comply with the National Electrical Code, Underwriters' Laboratories where applicable, and the Electrical Division of these Specifications.
- D. Class II wiring for the Automatic Temperature Control System in plenum ceiling spaces or in corridor ceiling spaces shall be run in EMT or with plenum-rated cable. All control wiring in exposed locations must be installed in metallic conduit. Power line carrier devices or RF signaling devices may not be used. All system components and sensors must be hard-wired. Minimum size conduit shall be 3/4". All cable shall be bundled and neatly strapped to roof joists. Laying wire on top of ceiling shall NOT be allowed. Flexible metal conduits and liquid-tight, flexible metal conduits

shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal conduit less than 1/2-inch electrical trade size shall not be used. In areas exposed to moisture, liquid-tight, flexible metal conduits shall be used. All liquid-tight conduits shall have interior metal core.

- E. Where wiring in exposed, occupied spaces cannot be concealed, wire mold shall be used.
- F. For installation of wall sensor control wiring, use the existing conduit where applicable.

3.6 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequate for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- D. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.
- E. Install duct static pressure tap with tube end facing directly down-stream of air flow.
- F. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.
- G. All pipe mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat conducting fluid in thermal wells.
- H. Wiring for space sensors shall be concealed in System walls. EMT conduit is acceptable within mechanical and service rooms.
- I. Install outdoor air temperature sensors on north wall complete with sun shield at designated location.

3.7 WARNING LABELS

- A. Affix labels on each starter and equipment automatically controlled through the DDC System. Warning label shall indicate the following:

CAUTION

This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

- B. Affix labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects. Labels shall indicate the following:

CAUTION

This equipment is fed from more than one power source with separate disconnects.
Disconnect all power sources before servicing.

3.8 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory fabricated panels, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information.
- B. Permanently label or code each point of field terminal strips to show the instrument or item served.
- C. Identify control panels with minimum 1/2" letters on nameplates.
- D. Identify all other control components with permanent labels. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

3.9 CONTROLLERS

- A. Provide a separate Controller for each major piece of HVAC equipment. A custom application controller may control more than one system provided that all points associated with that system are assigned to the same controller. Points used for control loop reset such as outside air or space temperature are exempt from this requirement.
- B. System Controllers and Custom Application Controllers shall be selected to provide a minimum of 15% spare I/O point capacity for each point type found at each location. If input points are not universal, 15% of each type is required. If outputs are not universal, 15% of each type is required. A minimum of one spare is required for each type of point used.
 - 1. Future use of spare capacity shall require providing the field device, field wiring, points database definition, and custom software. No additional Controller boards or point modules shall be required to implement use of these spare points.

3.10 PROGRAMMING

- A. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25% of available memory free for future use.
- B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.
- C. Software Programming:
 - 1. Provide programming for the system as written in the specifications and adhere to the sequence strategies provided. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the Control System Contractor. Imbed into any custom-written control programs sufficient comment statements or inherent flow diagrams to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.
- D. Operators' Interface:
 - 1. Standard Graphics. Provide graphics for each major piece of equipment and floor plan in the System. This includes each Rooftop Air Conditioning Units, VAV Terminal, and split systems. These standard graphics shall show all points dynamically as specified in the points list.
 - 2. The controls contractor shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.
 - 3. As part of this execution phase, the controls contractor will perform a complete test of the operator interface. Test duration shall be a minimum of 16 hours on-site. Tests shall be made in the presence of the Owner or Owner's representative.
- E. Demonstration: A complete demonstration and readout of the capabilities of the monitoring and control system shall be performed. The contractor shall dedicate a minimum of 16 hours onsite with the Owner and his representatives for a complete functional demonstration of all the system requirements. This demonstration constitutes a joint acceptance inspection, and permits acceptance of the delivered system for on-line operation.

3.11 CLEANING

- A. This contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.

- B. At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making it free from dust, dirt and debris, etc.
- C. At the completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.12 TRAINING

- A. Provide a minimum of 4 classroom training sessions, 4 hours each, throughout the contract period for personnel designated by the Owner. Computer-based audio-visual training may be substituted for up to 8 hours of hands on training.
- B. Train the designated staff of Owner's representative and Owner to enable them to proficiently operate the system; create, modify and delete programming; add, remove and modify physical points for the system, and perform routine diagnostic and troubleshooting procedures.
- C. Additional training shall be available in courses designed to meet objectives as divided into three logical groupings; participants may attend one or more of these, depending on the level of knowledge required:
 - 1. Day-to-day Operators
 - 2. Advanced Operators
 - 3. System Managers/Administrators
- D. Provide course outline and materials as per Part 1 of this Section. The instructor(s) shall provide one copy of training material per student.
- E. The instructor(s) shall be factory-trained instructors experienced in presenting this material.
- F. Classroom training shall be done using a network of working controllers, representative of the installed hardware or at the customer's site.
- G. This training shall be made available in addition to the interactive audio-visual tutorial, provided with the system.

3.13 COMMISSIONING

- A. The BAS/ATC Contractor shall submit for approval with their shop drawings, a detailed procedure for commissioning the entire Automatic Temperature Control System. As a minimum, the following items shall be included in the Commissioning Procedure:
 - 1. Software:

- a. Sequence of Operation
 - b. Control Loops
 - c. Inputs/Outputs
 - d. Building Management
 - e. Energy Management Software
- 2. Hardware:
 - a. Direct Digital Control Panels
 - b. Remote Communications
 - c. Inputs/Outputs
 - d. Testing procedures for control devices that are not factory-mounted and tested with their respective equipment.
- 3. Opposite season tests:
 - a. Software/Hardware

3.14 ACCEPTANCE

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

END OF SECTION 230900

SECTION 260100 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SCOPE OF WORK

- A. This Section of the Specifications describes the material and installation procedures to be followed for furnishing and installing the electrical equipment and material as outlined and described on the contract drawings and as stated in this Division of the Specifications.
- B. Where the word "Contractor" appears in this Division of the Specifications, it applies to the Contractor performing the electrical portion of the work, unless specifically indicated otherwise.
- C. The Contractor shall install the systems as specified herein and indicated on the contract drawings and shall furnish all labor, material, tools, scaffolds, erection equipment, services and other items of expense as necessary as a part of this Contract. This Contract further includes placing the systems into operation and properly testing, adjusting, balancing and training the owner's personnel on the use of all items of equipment as specified and as approved by the Architect.

1.3 SUPERVISION

- A. The Electrical Contractor shall have a competent and English speaking designated Supervisor who is a Certified Master Electrician on the job site at all times that any electrical work is being performed. This shall include any and all electrical work being accomplished by contractors who are subcontractors to the prime Electrical Contractor.

1.4 DRAWINGS

- A. General arrangements of the necessary conduits, feeders, light fixtures, devices, panels, and equipment are indicated on the drawings in diagrammatic form only. Due to the scale of the drawings, offsets, fittings, and accessories may not be shown. Work indicated but having details omitted shall be provided complete to an operating condition with all fittings, wiring, and ancillary equipment and material as required. Where rearrangement is necessary, submit drawings of proposed changes for approval and coordinate and arrange

work with consideration to the architectural, structural, mechanical, plumbing, and sprinkler system drawings, the existing building conditions and to the work of the various other building trades. Equipment provided under this Division of the Specifications shall be installed in accordance with the recommendations of the equipment or material manufacturer.

1.5 COORDINATION

- A. Coordinate the electrical work with the architectural, structural, mechanical, plumbing, and sprinkler system drawings and work in order to avoid omissions and to eliminate any interference. Report any discrepancies found, as soon as possible, after discovery, to the Architect.
- B. The contractor shall be responsible for coordinating with the Division 23 Contractor for providing properly sized circuit breakers to serve mechanical equipment and motors furnished which differ from that specified or indicated. This shall be further understood to include branch circuit wiring, conduit, disconnect switches, etc., in accordance with the appropriate codes and specifications. The cost of providing this increased electrical service and related work shall be included under the applicable section under which the equipment and motors are being furnished, at no additional cost to the Owner.
- C. The contractor shall coordinate the following electrical requirements for all mechanical equipment with the Division 23 Contractor:
 - 1. Number of electrical connections.
 - 2. Number and size of feeders' terminal lugs.
 - 3. Maximum overcurrent protection.
 - 4. Size and type of fuses.

1.6 CODES AND STANDARDS

- A. Various recognized codes and standards form a part of these Specifications the same as if written fully herein and shall be followed as minimum requirements. The codes and standards will be referred to by their abbreviated names and are listed below. Reference to these standards shall be understood to mean the latest edition and accumulative supplements which have been adopted by the "Authority Having Jurisdiction," unless noted otherwise.

| | |
|-------|---|
| ASAD | ADA Standards for Accessible Design |
| ANSI | American National Standards Institute |
| ASTM | American Society for Testing and Materials |
| CBMA | Certified Ballast Manufacturers Association |
| ICC | International Code Council |
| ICEA | Insulated Cable Engineers Association |
| IECC | International Energy Conservation Code |
| IEEE | Institute of Electrical and Electronics Engineers |
| IESNA | Illuminating Engineering Society of North America |
| LEED | Leadership in Energy and Environmental Design |

| | |
|----------|--|
| NEC 2020 | National Electrical Code |
| NEMA | National Electrical Manufacturers Association |
| NESC | National Electrical Safety Code |
| NFPA | National Fire Prevention Association |
| NFPA 70E | Standard for Electrical Safety in the workplace |
| OSHA | The Occupational Safety and Health Act |
| UL | Underwriters Laboratories, Inc. |
| VUSBC | Virginia Uniform Statewide Building Code, 2021 Edition |

- B. All equipment, material, apparatus, and work shall conform to the requirements of the NEC. If the Contractor observes that the drawings and specifications are at variance therewith, the contractor shall notify the Architect in writing. If the Contractor performs such work contrary to the above referenced rules and regulations and without written acknowledgment or notice thereto, they shall correct this work and bear all cost arising therefrom.

1.7 NOTICES AND FEES

- A. Give all required notices, obtain all necessary permits, and pay all required fees, including any fees associated with temporary electrical power services during construction. Utility company fees, which are for the permanent installation of electrical power services, shall be paid for by the Owner.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. Refer to Specification 013300 "Submittals", for shop drawing submittal procedures. Submit shop drawings for materials required for this project as indicated herein. Obtain approval from the Architect before manufacture is started on any of same. The shop drawings shall show complete details of the various items, wiring diagrams, etc., and shall be submitted in a sufficient number of copies to allow the Engineer to retain one copy. Approved copies of all shop drawings shall be kept on the job site accessible to the Architect at all times. All new power distribution equipment (panelboards, disconnect switches, transformers, contactors, and other power related components) shall all be by the same manufacturer.

2.2 ACCEPTABLE MANUFACTURERS

- A. The following list states specific names of acceptable manufacturers of particular equipment and indicates the types of material on which submittals shall be made:

Submittal Information
Required:

Light FixturesProduct Data
See light fixture schedule on drawings

NOTE: If substitute light fixtures are submitted for review, provide catalog data on the substitution which will provide all the information required to compare it to the specified product. At a minimum, provide dimensional and weight data, coefficients of utilization (CU) information, and photometrics for both the specified and substitute light fixtures. Lighting Shop Drawings not submitted with cut sheets for both Basis of Design and alternate light fixtures will be returned with “REJECTED – FURNISH SPECIFIED ITEMS”.

| | |
|--|---------------|
| Power Distribution Equipment (Panelboards) | Shop Drawings |
| General Electric / ABB Company | |
| Square D Company | |
| Eaton/Cutler-Hammer | |
| Siemens | |

| | |
|---|--------------|
| Lighting Contactors & Disconnect Switches | Product Data |
| General Electric / ABB Company | |
| Square D Company | |
| Eaton/Cutler-Hammer | |
| Siemens | |

| | |
|--------------------------------|--------------|
| Magnetic Contactors | Product Data |
| General Electric / ABB Company | |
| Square D Company | |
| Eaton/Cutler-Hammer | |
| Siemens | |

| | |
|--------------------------------|--------------|
| Surge Protective Devices | Product Data |
| Liebert | |
| Square D | |
| Eaton | |

| | |
|---------------------------------------|--------------|
| Wiring Devices and Cover Plates | Product Data |
| Hubbell | |
| Leviton | |
| Arrow-Hart | |
| Pass and Seymour | |

| | |
|--------------------------------|--------------|
| Dry-type Transformers | Product Data |
| General Electric / ABB Company | |
| Square D Company | |
| Eaton/Cutler-Hammer | |
| Siemens | |

| | |
|----------------------------|--------------|
| Cable Tray and Racks | Product Data |
| B-Line Systems | |
| MP Huskey | |
| Mono Systems | |

Surface Metal Raceway.....Product Data
Wiremold
Hubbell Incorporated
Mono Systems

- B. The following list states other materials for which product data submittals shall be made:

Cable Tray
CCTV Systems Components
Circuit Breakers (each type)
Conductors (each type)
Conduit (each type)
Data Network Cabling and Components
Fire Alarm System Components
Fuses (each type)
Intrusion Detection System Components
Integrated Communication System Components
LED Drivers
LED Lamps
Lighting Contactors
Master Clock System Components
MC Cable (each type)
Occupancy Sensing Switches (all types)
Short Circuit Coordination Study and Arc Flash Hazard Analysis
Surface Metal Raceway (including all accessory components)

- C. Catalog numbers and manufacturers are listed as a guide for minimum requirements to be met. Material and equipment of manufacturers other than those listed will be given consideration by the Architect providing the material meets the minimum requirements set forth in these Specifications and providing the material or equipment will provide satisfactory performance for the intended installation, does not exceed the dimensions and weight of the specified item and meets the aesthetic performance desired of the specified item. Submittals of other than specified equipment shall have indicated on the specification sheets in the shop drawing submittals each item called for in these Specifications by paragraph and subparagraph numbers and/or letters.
- D. Refer to Specification Section 012500 for substitution requirements.
- E. Any deviation from the manufacturers listed in the preceding list and /or of those stated in the Contract Documents shall be submitted to the Architect for approval in accordance with Specification Section 260500, "Materials and Methods." Facsimile transmission of data for review will not be accepted.
- F. The Engineer will review for approval, only one substitute for each type of material specified in the Division 26 Contract Documents. If the substitute material is not approved, the Contractor shall provide the material by one of the specified manufacturers. Approval of substitute material is at the sole discretion of the Architect and Owner, and the Contractor shall bear all costs arising therefrom, including any design fees if additional design effort is deemed prudent or necessary by the Architect.

- G. Only the types of materials specified herein are approved for use on this project. No other material types will be considered.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. "Provide," as used on the drawings and in these Specifications, shall mean furnish, install, connect, adjust, test, and place into operation, except where otherwise specifically stated in the contract documents.
- B. Provide coordinated electrical systems, equipment, and material complete with auxiliaries and accessories as required for a complete and operable finished project.
- C. Run all conduits concealed except where specifically indicated otherwise. Exposed conduit installation other than where indicated shall be approved by the Architect and Owner prior to installation.

3.2 CLEANING

- A. Remove all dirt, trash, and oil from all raceways, boxes, fittings, cabinets, and panelboards.
- B. Protect, to the satisfaction of the Architect, all equipment provided against damage during construction. If damage does occur to any materials, refinish, repair, or replace the equipment or material as directed by the Architect.

3.3 REPAIR OF EXISTING WORK

- A. Repair of existing work, demolition, and modification of existing electrical distribution systems shall be performed as follows:
 - 1. Workmanship: Lay out work in advance.
 - a. Exercise care when cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces as necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to buildings and materials or equipment damaged using skilled craftsmen of the appropriate trades.
 - 2. Existing Concealed Wiring to be Removed:
 - a. Existing concealed wiring to be removed shall be disconnected from its source. Remove conductors and cut conduits flush with concrete floors, and top openings with non-shrink grout. Where wood floors are encountered, remove conduit to below wood floor. Where conduit that passes through

walls is removed, seal opening in wall with a material that is equal to the fire rating of the material the wall is constructed from.

3. Continuation of Service:

- a. Maintain continuity of existing circuits to remain. Existing circuits shall remain energized unless otherwise indicated. Circuits which are to remain but were disturbed during demolition shall have circuit wiring and power restored back to original condition as approved by the Architect. Only materials specified for this project may be used to affect repairs.

3.4 EXCAVATION

- A. All excavations shall be made to the proper depth to assure a firm foundation for the work.

3.5 RECORD DRAWINGS

- A. Refer to Specification Section 017839 "Project Record Documents".

3.6 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Specification Section 017823 "Operation and Maintenance Data".

The following list states materials for which Operation and Maintenance Data submittals shall be made:

- CCTV Systems Components
- Data Network Cabling and Components
- Elevator Emergency Communication System
- Fire Alarm System Components
- Intrusion Detection System Components
- Integrated Communication System Components
- Light Fixtures
- Master Clock System Components
- Power Distribution Equipment (Panelboards, Dry Type Transformers, Lighting Contactors & Disconnect Switches)
- Short Circuit Coordination Study and Arc Flash Hazard Analysis
- Occupancy Sensing Switches (all types)
- Surge Protective Devices
- Wireless Clock Systems

3.7 EQUIPMENT INVENTORY

- A. Provide a complete equipment inventory for all Electrical Equipment listed below. Refer to Appendix A in this section for the required template. A separate form shall be provided for each new piece of equipment provided.

- B. Prior to substantial completion, submit the equipment inventory forms for review. Once approved, include the forms in the operation and maintenance manual.

The following list states materials for which equipment inventory shall be made:

- CCTV Systems Components
- Data Network Cabling and Components
- Elevator Emergency Communication System
- Fire Alarm System Components
- Intrusion Detection System Components
- Integrated Communication System Components
- Light Fixtures
- Master Clock System Components
- Power Distribution Equipment (Panelboards, Dry Type Transformers, Lighting
Contactors & Disconnect Switches)
- Occupancy Sensing Switches (all types)
- Surge Protective Devices
- Time Clocks
- Wireless Clock Systems

APPENDIX A

New Equipment Inventory

Project Name: (Add Project Name)

Project Address: (Add Project Address)

Description of Item: _____
(ex. Switchboard, Panelboards, Generator, Lighting, etc.)

Classification:

- ☐ Lighting
☐ Power Distribution
☐ Auxiliary Systems

Building: _____

Equipment Location (Room Number): _____

Date Purchased: _____

Date Placed in Service: _____

Original Cost: _____

Life Expectancy (years): _____

Estimated Replacement Date: _____

Estimated Replacement Cost: _____

Manufacturer: _____

Model/Serial #: _____

END OF SECTION 260100

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SECTION 260500 - MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SCOPE OF WORK

- A. Provide all labor, material, tools, scaffolds, erection equipment, services and supplies to fabricate, install, connect, adjust, test, and place in operation the electrical and other systems as called for in these Specifications and as indicated on the Contract Drawings.
- B. Properly store and protect all material and equipment until installed.
- C. All material and equipment shall be new and of the quality noted or specified. Material, equipment, and work of inferior quality will be rejected and shall be removed from the job site immediately upon rejection and replaced. Unacceptable work shall be removed and replaced. All replacement material and work shall be done at the Contractor expense. The Architect will decide upon the quality of material and equipment furnished and of the work performed.

1.3 WARRANTIES

- A. The Contractor shall provide the Owner with a one-year, unlimited material and labor warranty on all work accomplished and materials provided under Division 26, 27, 28, including all components thereof except as otherwise noted herein or in other specifications. The warranty start date is the date of project "Substantial Completion" as determined by the Architect. All warranties shall be submitted as part of the shop drawing submittals.
- B. Electronic Fluorescent and HID Ballasts shall be free from defect in material and workmanship for a period of five (5) years from the date of project "Substantial Completion" as determined by the Architect.
- C. Electronic LED drivers shall be free from defect in material and workmanship for a period of five (5) years from the date of project "Substantial Completion" as determined by the Architect.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Electrical material furnished under these Specifications shall be new and listed by UL and shall bear the UL label where labeling service is available for the type of material provided for this project.

2.2 RACEWAYS

- A. Raceways shall be of the size indicated or as required by the NEC; whichever is the larger; except where larger conduits are specified on the Contract Drawings. Raceways shall be 1/2" minimum.
- B. Raceways shall be provided for all electrical systems indicated on the drawings unless specifically indicated otherwise. Raceways shall be hot-dip galvanized rigid steel conduit (GRS), electrical metallic tubing (EMT), flexible steel conduit, or intermediate metallic conduit (IMC). Flexible steel conduit in kitchen areas, and outdoors shall be liquid tight. Schedule 40 PVC conduit may be used only below grade, under concrete slabs-on-grade and other locations where specifically indicated.

2.3 CONDUCTORS

- A. Conductors shall be of the American Wire Gauge size indicated on the contract drawings or specified herein.
- B. All conductors shall be copper. The use of Aluminum conductors is not permitted.

2.4 OUTLETS

- A. Outlet and junction boxes shall be of one-piece galvanized construction of a type and size applicable for use in the location indicated on the contract drawings and as required by the NEC.
- B. Locations of outlets for lighting, devices, power, and equipment are indicated on the contract drawings. Owing to the small scale of the drawings, it is not possible to indicate the exact location. Examine the architectural, structural, mechanical, sprinkler system and plumbing drawings, and finish conditions and arrange work as required to meet such conditions to the approval of the Architect.
- C. Verify the exact swing of doors and locations of furniture and built-in cabinetry prior to installing outlets for switches and receptacles and make the necessary adjustments in location and mounting height of same to avoid conflicts at no additional cost. Coordinate outlets with change orders, addenda, and job site differences.

2.5 FUSES

- A. All fuses shall be provided by the Electrical Contractor.
- B. Fuses shall be as follows:
 - 1. General: All fuses must carry the UL inspected label. All fuses shall be plainly marked with ampere rating, voltage rating, interrupting capacity when greater than 10,000 Amperes and current limiting where it applies, and the name of the trademark of the manufacturer.
 - 2. Interrupting Capacity: Each fuse shall be capable of safely interrupting the maximum short-circuit current available at the point in the circuit where installed.
 - 3. Coordination: Service fuses and the fuses installed in feeder circuits shall be coordinated to provide a selective system of over-current protection.
- C. Main, feeder, and branch circuit fuses shall be as follows:
 - 1. Circuits 0 to 600 amperes shall be protected by BUSSMANN Low-Peak, Limitron, or Fusetron (RK5, 200,000 I/C) Fuses rated as indicated on the drawings.
 - 2. Motor Circuits: All motors rated 480 volts or less shall be protected by dual-element fuses rated not in excess of 175% and not less than 125% of motor nameplate rating or as indicated. Larger motors as indicated on drawings where fuse gaps are larger than size required for proper rating of fuse, install "all-metal" fuse reducers.

2.6 LABELING

- A. Label all disconnect switches, panelboards, motor controllers, transformers, and lighting contactors provided under Division 26 of these Specifications.
- B. Labels shall be machine engraved, laminated, Bakelite, nameplate type. Labels shall have black faces with white letters except for fire alarm cabinet and emergency panels where the faces shall be red with white letters.
- C. Size of labels shall be based on the required lettering and lettering size. The following are the minimum requirements for each type of label:
 - 1. Panelboards and Transformers: The First line of label shall state name of panel as shown on the drawings. The Second line shall state from where the panel is fed. Lettering shall be 3/8" high.

| | | |
|----------|-----------------|-------------------|
| Example: | Panel L-100 | Transformer TC-1 |
| | Fed from MDS | Fed From Panel #1 |
| | Circuit # _____ | Circuit # _____ |
| | Voltage _____ | Voltage _____ |
 - 2. Motor Controller: Motor controller shall be labeled in 1/4" high letters. The First line shall state the duty of motor and number if more than two motors have the same duty. The Second line shall state from what panel the controller is fed.

Example: Chilled Water Pump No. 2
Fed from Panel 100
Circuit # _____
Voltage _____

3. HVAC equipment with integral disconnects shall be labeled on the outside of the equipment housing at the location of the disconnect in the same manner as Motor Controllers. The HVAC equipment shall be labeled in 1/4" high letters. First line shall state the name of the equipment as it appears on the electrical drawings. Second line shall state from what panel the equipment is fed.

Example: Roof Top Unit No. RTU-2
Fed from Panel 100
Circuit # _____
Voltage _____

4. Disconnect Switches/Lighting Contactors: Disconnect switches and lighting contactors shall be labeled in 1/4" high letters. The First line shall state what the switch/contactors is feeding. The Second line shall state from which circuit and panel the switch/contactors is fed.
 5. Disconnect switches feeding elevator equipment and cab lights shall be labeled per ANSI/ASME A17.1 and NEC 620-53 in addition to the above.
- D. Circuit breakers serving Fire Alarm Control Panels shall be provided with a red, Bakelite nameplate with white letters attached to the panel adjacent to the circuit breaker.
- E. Attach labels with a minimum of two rivets or sheet metal screws. Adhesive-backed labeling will not be accepted.
- F. Workspace indication for all electrical equipment (Panelboards, and Transformers): Provide 3" wide, 5 mil floor marking safety vinyl tape (striped black and yellow) to show working clearances in the direction of access to live parts. Working clearance around equipment shall not be less than those listed in the N.E.C, Article 110.26 for all voltages specified. Do not install in front of flush-mounted or surface-mounted panelboards and similar equipment in finished spaces, unless directed by the owner.

2.7 PULL BOXES

- A. Install pull boxes at all necessary points, whether indicated on the drawings or not, to prevent injury to conductor insulation or other damage that might result from pulling resistance or for other reasons necessary for proper installation. Minimum dimensions shall not be less than the NEC requirements and shall be increased if necessary for practical reasons or where required to fit the job condition.
- B. Above grade pull boxes shall be constructed of galvanized sheet steel, code gauge, except that not less than 12-gauge shall be used for any box. Where boxes are used in connection with exposed conduit, plain covers attached to the box with a suitable number of countersunk flathead machine screws may be used.

- C. All junction and pull box covers shall be labeled indicating the circuits contained therein in a manner that will prevent unintentional interference with circuits during testing and servicing. For example: "HE1-13." See Specification Section 260534 for additional labeling requirements.

2.8 DISCONNECT SWITCHES

- A. Disconnect switches shall conform to governing industry NEMA standards. They shall be listed by UL. Disconnect switches shall be NEMA standard HD, quick-make, quick-break type, and capable of being locked in the off position.
- B. Where disconnect switches are indicated or required by the NEC to be weatherproof, furnish NEMA 3R enclosures. Furnish NEMA 4X enclosures in kitchen areas and other spaces where specifically indicated.

2.9 BRANCH CIRCUITS

- A. The branch circuit wiring has been designed to utilize the advantages of multi-wire distribution and shall be installed substantially as indicated on the drawings. Major changes in the grouping or general routing of the branch circuits require prior approval in writing from the Architect/Engineer.
- B. The number of conductors in each run of conduit is indicated on the drawings, but where there is a conflict between the number of wires indicated and the actual number required as determined by the functional requirements of the connected load, or where the number of wires was inadvertently omitted from the drawings, the correct number and size of wires as determined by the functional requirements of the connected load shall govern and be provided at no additional cost.
- C. Where individual 120V or 277V homerun circuits are shown on the drawings, they may be combined as follows:
 - 1. No more than three phase conductors plus three neutrals and one ground per conduit.
 - 2. No two of the same phase conductor per conduit.
 - 3. Provide 120V circuits with individual neutrals per circuit. Neutrals may not be shared.
 - 4. Neutral sharing by 277V circuits is acceptable.

2.10 MOTOR AND CONTROLLER DISCONNECTING MEANS

- A. Provide a disconnecting means for each motor, where indicated on the drawings. A circuit breaker in a panelboard, horsepower rated switch, or type specified under Article 430 and 440 of the NEC will be acceptable as a disconnecting means, if readily accessible and if located within sight of the motor and in compliance with all codes. A quick-make and quick-break general use tumbler or snap switch will be acceptable for capacities of 20 amperes or less and 300 volts and less, provided the ampere rating of the switch is at least

double the rating of the equipment controlled. Switches of 30- to 400-ampere capacity shall be of the enclosed, quick-make and quick-break type, heavy duty, horsepower rated. Switches shall disconnect all ungrounded conductors and shall disconnect grounded conductors if required by the NEC or if called out on the drawings to do so. Switches shall be fusible type where indicated on the drawings.

2.11 CABLE TIES

- A. Provide cable ties in the length required. Standard, indoor cable ties shall be 7.9 inches in length minimum, 0.19 inches in width and 0.47 inches thick. The tensile strength shall be 50 pounds minimum and the maximum bundle diameter shall be 2 inches. Standard cable ties shall be black in color. Plenum rated cable ties shall be 6 inches in length minimum, .075 inches in width and 0.1 inches thick. The tensile strength shall be 50 pounds minimum and the maximum bundle diameter shall be 1.5 inches. Plenum rated cable ties shall be maroon in color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install material in a first-class and workmanlike manner to the satisfaction of the Architect.

END OF SECTION 260500

SECTION 260518 - METAL CLAD CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specifications Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 DESCRIPTION

- A. Aluminum Metal clad cables may be utilized for branch circuit wiring in walls and above lay-in-tile ceilings only and installed in accordance with NEC 330.

1.3 REFERENCES

- A. Aluminum Metal clad cable shall be constructed in strict accordance with Underwriters Laboratories, Inc. Standard for Aluminum Metal Clad Cables, UL 1569. The cable shall bear the UL label and the manufacturer's "E" number.
- B. Further, the product shall have passed UL Test Procedure 1479, Through Penetration Fire Rating, and meet NEC 330.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Provide electrical wires, cables, and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer for a complete installation and for application indicated. Except as otherwise indicated, provide copper conductors with conductivity of not less than 98% at 20°C (75°F).
- B. Wiring sizes #12 and #10 AWG shall be solid. Larger sizes may be stranded.
- C. All branch circuits and control wiring shall have color coded conductors to reflect the appropriate phase and voltage. Color coded identification bands shall be integral with the exterior armor sheath from the manufacturer for sizes #12, #10 and #8. If larger size cable is not available to meet these requirements, the conductors shall be identified per phase and voltage with a minimum of 3 wraps of ½" wide electrical tape. The cable sheath shall be

color coded with bands of tape identifying each phase conductor per voltage and neutral conductor contained in the sheath. The sheathing shall be identified every 10', within 6" of any box, entering a wall cavity and 6" either side of passing through a wall.

2.2 FITTINGS

- A. Fittings shall be UL listed and identified for use with metal clad cable.
- B. Connectors shall be of steel or malleable iron and shall have saddle clamp to insure a tight termination of MC Cable to box.
- C. The cable end shall be cleanly cut with metal clad cable rotary cutting tool to ensure flush seating of the cable into the fitting. Fitting securement screws shall be properly torqued.
- D. Provide anti-short bushings in accordance with NEC
- E. The use of snap-in type connectors is not acceptable.

PART 3 - EXECUTION

3.1 SPLICES

- A. Splicing connectors must have a metal spring that is free to expand. The spring must be suitably coated to resist corrosion. Each connector size must be listed by UL for the intended purpose. The connectors must be suitably color coded to assure that the proper size is used on the wire combinations to be spliced. Each connector must be capable of withstanding 105°C ambient temperatures. The connectors must be compatible with all common rubber and thermoplastic wire insulations. They must also be capable of making copper-to-copper, copper-to-aluminum, and aluminum-to-aluminum splices. At the Contractor's option, self-strapping electrical tap connectors may be used in wire size and voltage range of the connector. When tape is required for splices, SCOTCHBRAND No. 33, or approved equal, shall be used. Use plastic tape on PVC and its copolymers and rubber-based pressure-sensitive adhesive. The tape must be applicable at temperatures ranging from 0°F through 100°F without loss of physical or electrical properties. The tape must not crack, slip, or flag when exposed to various environments indoor or outdoor. The tape must also be compatible with all synthetic cable insulations as well as cable splicing compounds.
- B. MC Cable used to serve light switches shall be provided with a neutral conductor.
- C. Make splices in conductors #8 AWG and larger with solderless connectors, with molded composition covers.
- D. Connect conductors #12 and #10 AWG with pre-insulated spring connectors rated at not less than 105°C. Connectors shall be UL approved for fixture and pressure work. Connectors shall be 3M CO. SCOTCHLOK, Type Y, R, and B, or approved equal.

- E. Join or terminate conductors #8 AWG and larger with pressure-type copper connectors and properly tape.
- F. All branch circuit and control wiring shall be color coded. The color shall be integral with exterior armer sheath for sizes #12, #10, and #8 AWG. Larger size wire and cable shall be color coded with a minimum 1/2" wide, colored, plastic tape strip. Place strips a minimum of 6" on center anywhere the conductors are accessible and visible. Wire and exterior sheath shall be color coded to match the existing color coding if an existing color code is present. If there is no existing color code, provide the following:

| <u>120/208-Volt System</u> | <u>277/480-Volt System</u> |
|-----------------------------------|-----------------------------------|
| Phase A - black | Phase A - brown |
| Phase B - red | Phase B - orange |
| Phase C - blue | Phase C - yellow |
| Neutral - white | Neutral - grey |
| Ground - green | Ground - green |

- G. Advise the Architect if the color coding provided by the utility company differs from that indicated above.

3.2 SUPPORT OF CABLE

- A. Where metal clad cables are exposed, run parallel with walls or structural elements. Vertical runs shall be plumb; horizontal runs level and parallel with structure, as appropriate. Groups shall be racked together neatly with both straight runs and bends parallel and uniformly spaced.
- B. Metal clad cables shall be securely fastened in place at intervals of not more than six feet, with suitable clamps or fasteners of approved type, and vertical runs shall be properly supported to present a secure installation. Cable ties used for supporting and securing MC cable, shall be listed, and identified for securement and support.
- C. Metal clad cable installed parallel to framing members, such as studs, joist, or rafters, shall be supported so that the nearest outside surface of the cable is not less than 1-1/4 inches from the nearest edge of the framing member. Where this distance cannot be maintained, the cable shall be protected by a steel plate, sleeve, or equivalent that is at least 1/16-inch thick.
- D. Maintain at least 6-inch clearance between metal clad cables and other piping systems. Maintain 12-inch clearance between metal clad cables and heat sources such as flues, steam pipes, and heating appliances.
- E. No metal clad cable shall be fastened to other conduits or pipes or installed to prevent the ready removal of other pipes or ducts for repairs.
- F. Individual metal clad cables hung from roof structure or structural ceiling shall be supported by split-ring hangers and wrought-iron hanger rods. Where three or more metal clad cables are suspended from the ceiling in parallel runs, use steel channels, Unistrut or

equal, hung from 1/4-inch rods to support the cables. The cables on these channels shall be held in place with metal clad cable clamps designed for the particular channel that is used.

- G. Secure metal clad cable support racks to concrete walls and ceilings by means of cast-in-place anchors; die-cast, rustproof alloy expansion shields; or cast flush anchors. Wooden plugs, plastic inserts, or gunpowder driven inserts shall not be used as a base to secure conduit supports.
- H. Metal clad cable shall be supported immediately on each side of a bend and not more than 1 foot from an enclosure where a run of metal clad cable ends.
- I. Metal Clad Cable shall be sleeved with metal pipe when passing through all masonry walls, fire rated walls and horizontally through a gypsum wall. No more than three cables shall be contained in one metal sleeve. Sleeves through gypsum type walls shall be secured during rough-in.

END OF SECTION 260518

SECTION 260519 - CONDUCTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SCOPE OF WORK

- A. Feeder and branch circuit wiring shall conform to the requirements of the NEC, and shall meet all relevant ASTM specifications.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Provide electrical wires, cables, and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer for a complete installation and for the application indicated. Provide copper conductors with a conductivity of not less than 98% at a temperature of 20°C (68°F).
- B. Provide factory-fabricated wires of sizes, ampacity ratings, and materials for applications and services indicated. Where not indicated, provide proper wire selection as determined by installer to comply with project's installation requirements, the NEC, and NEMA standards. Select from the following UL types those wires with construction features which fulfill project requirements:
 - 1. Type THWN or THHN: Max operating temperature not to exceed 90°C (194°F) (THHN) in dry locations, or 75°C (167°F) (THWN) in wet or dry locations. Insulation, flame-retardant, moisture- and heat-resistant, thermoplastic; outer covering, nylon jacket; conductor, annealed copper.
 - 2. Type XHHW: For dry and wet locations; max operating temperature 90°C (194°F) for dry locations, and 75°C (167°F) for wet locations. Insulation, flame-retardant, cross-linked synthetic polymer; conductor, annealed copper.
- C. Unless specified otherwise, power and lighting conductors shall be 600-volt, Type THWN/THHN, or XHHW.

- D. Where light fixtures require 90°C (194°F) conductors, provide only conductors with 90°C (194°F) insulation.
- E. Conductors shall be continuous from outlet to outlet with splices made only in pull boxes, junction boxes, and outlet boxes.
- F. Do not use wire smaller than #12 AWG for power or lighting wiring.
- G. Refer to other Division 26 specification sections for type and size of wiring for Class 1, 2, and 3 circuits (circuits under 120V).
- H. Wiring sizes #12 and #10 AWG shall be solid. Larger sizes may be stranded.
- I. Neutral conductors shall not be under sized.
- J. Where the standard lug sizes on circuit breakers and the main lugs on a main lug only panelboard and other equipment will not accept the conductor size specified, provide Burndy Copper Compression Pin Adapters HYPLUGS or approved equal. The use of Mechanical Pin Adapters will not be accepted.

PART 3 - EXECUTION

3.1 SPLICES

- A. Splicing connectors must have a metal spring that is free to expand. The spring must be suitably coated to resist corrosion. Each connector size must be listed by UL for the intended purpose. The connectors must be suitably color coded to assure that the proper size is used on the wire combinations to be spliced. Each connector must be capable of withstanding 105°C ambient temperatures. The connectors must be compatible with all common rubber and thermoplastic wire insulations. They must also be capable of making copper-to-copper, copper-to-aluminum, and aluminum-to-aluminum splices. At the Contractor's option, self-strapping electrical tap connectors may be used in wire size and voltage range of the connector. When tape is required for splices, SCOTCHBRAND No. 33, or approved equal, shall be used. Use the plastic tape on PVC and its copolymers and rubber-based pressure-sensitive adhesive. The tape must be applicable at temperatures ranging from 0°F through 100°F without loss of physical or electrical properties. The tape must not crack, slip, or flag when exposed to various environments indoor or outdoor. The tape must also be compatible with all synthetic cable insulations as well as cable splicing compounds.
- B. Make splices in conductors #8 AWG and larger with solderless connectors, with molded composition covers.
- C. Connect conductor sizes #12 and #10 AWG with pre-insulated spring connectors rated at not less than 105°C. Connectors shall be UL approved for fixture and pressure work. Connectors shall be 3M CO. SCOTCHLOK, Type Y, R, and B, or approved equal.
- D. Join or terminate conductors #8 AWG and larger with pressure-type copper connectors and properly tape.

- E. All branch circuits, feeders, and control wiring or cables of any type shall be color coded to identify the voltage and phase. The color shall be integral with the Insulation for sizes #12, #10, and #8 AWG. Larger size wire and cable shall be color coded with a minimum 1/2" wide, colored, plastic tape strip. Place strips a minimum of 6" on center anywhere the conductors are accessible and visible. Wire and cable shall be color coded to match the existing color coding if an existing color code is present. If there is no existing color code, provide the following:

| <u>120/208-Volt System</u> | <u>277/480-Volt System</u> |
|-----------------------------------|-----------------------------------|
| Phase A - black | Phase A - brown |
| Phase B - red | Phase B - orange |
| Phase C - blue | Phase C - yellow |
| Neutral - white | Neutral - gray |
| Ground - green | Ground - green |

- F. After all wiring is pulled and ready for operation but prior to placing systems in service, conduct insulation resistance tests in all feeder circuits. Measure the insulation resistance between conductors and between each conductor and ground. Make measurements with an instrument capable of making measurements at an applied potential of 500 Volts.
- G. Take readings after the voltage has been applied for a minimum of one minute. The minimum insulation resistance for circuits of #12 AWG conductors shall be 1,000,000 ohms. For circuits of #10 AWG or larger conductor, a resistance based on the allowable ampacity of the conductor shall be as follows:

| | |
|-------------------------|--------------|
| 25 through 50 Amperes | 250,000 ohms |
| 51 through 100 Amperes | 100,000 ohms |
| 101 through 200 Amperes | 50,000 ohms |
| 201 through 400 Amperes | 25,000 ohms |
| 401 through 800 Amperes | 12,000 ohms |
| Over 800 Amperes | 5,000 ohms |

- H. Submit the results of the insulation resistance tests to the Architect for approval. Provide readings for each circuit tested indicating the points between which the circuit was tested, reading, date and time of test, and name of the individual performing the test.
- I. Advise the Architect/Engineer in writing of the tests five (5) working days prior to the date the testing is to commence.
- J. Advise the Engineer if the color-coding provided by the utility company differs from that indicated above.

3.2 TEMPORARY WIRING

- A. Temporary wiring is not specified nor governed by this Division of the Specifications.

END OF SECTION 260519

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SECTION 260525 - SURFACE METAL RACEWAY

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SCOPE

- A. The work covered under this Section shall include furnishing and installing surface mounted metal raceways complete for all electrical systems as shown on the Drawings and herein specified. Surface raceway systems shall consist of raceway bases, covers, appropriate fittings, dividers, and device mounting plates necessary for a complete installation.
- B. All material and equipment shall be new and of the quality noted or specified. Material, equipment, and work of inferior quality will be rejected and shall be removed from the job site immediately upon rejection and replaced. Unacceptable work shall be removed and replaced. All replacement material and work shall be done at the Contractor expense. The Architect will decide upon the quality of material and equipment furnished and of the work performed.

1.3 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and materials shall be listed by Underwriters Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. Submittals are required in accordance with Section 260100 of these Specifications.

1.4 USES PERMITTED

- A. Surface mounted metal raceway shall be used where indicated on the drawings where new wiring is required on existing walls and on new walls as also indicated on the Drawings.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver raceway systems in factory labeled packages.
- B. Store and handle in strict compliance with manufacturer's written instructions and recommendations.
- C. Protect from damage due to weather, excessive temperature, and construction operations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Surface metal raceways shall be as manufactured by The Wiremold Company, as described herein as the basis of design, or equal products as manufactured by Hubbell Incorporated and Mono Systems.
- B. All components and fittings shall be of the same manufacturer, or UL listed as an assembly.

2.2 MATERIALS AND COMPONENTS

- A. All surface metal raceways shall be galvanized steel, unless otherwise indicated. Finish shall be white in color having a scratch-resistant surface (a polyester topcoat over a colored base) and shall be suitable for field repainting to match surroundings.
- B. A full complement of fittings must be available including but not limited to mounting clips and straps, couplings, flat, internal and external elbows, cover clips, tees, entrance fittings, wire clips, support clips, c-hangers, end caps, conduit connectors, bushings, and take-off fittings to adapt to flush wall boxes. The covers shall be painted with an enamel finish; colored to match the raceway. They shall overlap the raceway to hide uneven cuts. All fittings shall be supplied with a base where applicable to eliminate mitering. Transition fittings shall be available to adapt to other sizes and types of raceways of the same manufacturer. Provide all fittings, etc. for a complete installation.
- C. Device Boxes shall be suitable for the type of raceways provided and for mounting standard devices and faceplates. Device boxes shall be provided in single- and multiple-gang configurations, up to six-gang. Single-gang boxes shall allow for snap-on and fastener applications. They shall range in depth from 0.94" to 2.75". Extension boxes shall be provided to adapt to existing standard flush switch and receptacle boxes.
- D. The raceway manufacturer shall provide a complete line of connectivity outlets and modular inserts for UTP/STP, Fiber Optic, Coaxial and other cabling types with face plates and bezels to facilitate mounting. A complete line of preprinted station and port identification labels, snap-in icon buttons as well as write-on station identification labels shall be available. Provide as needed for a complete installation.

- E. Raceways used for communications cabling shall have a complete line of full capacity corner elbows and tee fittings, and used where required or shown on the Drawings, to maintain a controlled 2" cable bend radius which meets the specifications for Fiber Optic and UTP/STP cabling and exceeds the TIA 569 requirements for communications pathways.

2.3 SURFACE METAL RACEWAYS

- A. Wiremold Series 500 or 700 raceway shall be one-piece design with a base and cover factory assembled. The total width shall be 3/4" x 17/32" high with a capacity of 0.19 square inches for 500 or 3/4" x 21/32" with a capacity of 0.26 square inches for 700. The raceway base and cover shall be a minimum thickness of 0.040". The raceway shall be available in five (5) foot and ten (10) foot lengths.
- B. Wiremold Series 4000 raceway shall be a single-or dual-channel two-piece design with a metal base and snap-on metal cover. Base shall be dividable by means of a removable barrier section into two equal compartments. The assembled base and cover shall be 4 3/4" wide x 1 3/4" high with a capacity of 7.20 square inches for undivided raceway and a capacity of 3.10 square inches for each compartment of the divided raceway. The raceway base shall be a minimum thickness of 0.050 inches and the cover with a minimum thickness of 0.040". The raceway base shall be available in ten (10) foot lengths and the cover shall be available in five (5) foot lengths.
- C. Plastic device mounting bracket and trim plates shall be provided to install devices horizontally within the raceway. Trim plate shall overlap the cover-eliminating seam. Faceplates shall accept a variety of power and data/communication devices. Plastic must be compatible with UL 94 for plastic Materials. Device brackets and trim plates shall be colored to match the raceway.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions under which surface raceways, boxes, distribution systems, accessories, and fittings will be installed and substrate that will support raceways. Notify the Architect of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Surface raceways shall be installed in strict compliance with the manufacturer's installation instructions and recommendations and approved shop drawings. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.
- B. Surface raceways shall be installed parallel with or at right angles to building structure and at the mounting heights noted on Drawings.

- C. Surface raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets, in accordance with manufacturer's installation sheets.
- D. Metal raceways shall be electrically continuous and bonded in accordance with the National Electrical Code for proper grounding.
- E. Surface raceway shall be supported at intervals not exceeding five (5) feet or in accordance with manufacturer's installation sheets using appropriate anchors and screws. The use of drive pins and/or other methods using compressed air or gases are not acceptable.
- F. Provide accessories as required for a complete installation, including insulated bushings and inserts where required by the manufacturer.
- G. Close all unused raceway openings using manufacturer's recommended accessories.
- H. All surface raceway connections to outlet and/or junction boxes shall be made using adjustable offset connectors or combination connectors as detailed on the Drawings. The connectors shall be furnished by the manufacturer of the surface raceway.
- I. Field cutting of surface raceways base and covers shall be accomplished by the use of the manufacturer's raceway cutters specifically designed for this purpose.

3.3 CLEANING AND PROTECTION

- A. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer.
- B. Protect raceways and boxes until final acceptance by the Owner.
- C. Repaint marred and scratched surfaces with touch-up paint to match original finish.

END OF SECTION 260525

SECTION 260526 - GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SCOPE OF WORK

- A. Provide grounding for conduits, motor frames, metal casings, receptacles, and solid neutral, and as required by NEC Article 250.

PART 2 - PRODUCTS

2.1 GROUND WIRE

- A. Provide a green insulated ground wire, sized per the NEC, in all conduits, junction boxes, and pull boxes.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Connect grounding conductors to the panelboard equipment ground bus and not to the panelboard neutral bus. Also connect grounding bushings to the ground bus. Connect the neutral bus only to the system neutral wire. Provide a bonding wire between the equipment ground bus and the neutral bus in the main distribution equipment only. The grounding system (conduit, cabinets, enclosures, and grounding conductors) and the grounded system (neutral conductors and service equipment ground) shall be separate and independent systems, except at the main distribution equipment.
- B. Test resistance to ground and submit readings to the Architect for review. Include the date and time of the test and the name of the individual performing the test.

END OF SECTION 260526

**NORTHERN SHORES ELEMENTARY SCHOOL ADDITION
SUFFOLK PUBLIC SCHOOLS**

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SECTION 260529 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SCOPE OF WORK

- A. Extent of supports, anchors, sleeves, and seals is indicated in other Division 26 Sections.
- B. Types of supports, anchors, sleeves, and seals specified in this Section include the following:
 - C-clamps
 - I-beam clamps
 - One-hole conduit straps
 - Two-hole conduit straps
 - Round steel rods
 - Expansion anchors
 - Toggle bolts
 - Wall and floor seals
 - Minerallac Straps
 - 2-Piece Strutt Straps
 - Slotted Channel
 - Cable Ties
- C. Supports, anchors, sleeves, and seals furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 26 Sections.

1.3 QUALITY ASSURANCE

- A. Furnish supporting devices manufactured by firms regularly engaged in manufacture of supporting devices of types, sizes, and ratings required.
- B. Comply with the requirements of the NEC, as applicable to construction and installation of electrical supporting devices.

- C. Comply with applicable requirements of ANSI/NEMA FB1, "Fittings and Supports for Conduit and Cable Assemblies."
- D. Comply with NECA "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.
- E. Provide electrical components which are UL-Listed and labeled.

PART 2 - PRODUCTS

2.1 MANUFACTURED SUPPORTING DEVICES

- A. Provide supporting devices complying with manufacturer's standard materials, design, and construction in accordance with published product information and as required for a complete installation, and as herein specified. Where more than one type of device meets indicated requirements, selection is installer's option.
- B. Provide supporting devices of types, sizes, and materials required, and having the following construction features:
 - 1. Reducing Couplings: Steel rod reducing coupling, 1/2" by 5/8"; galvanized steel; approx. 16 pounds per 100 units.
 - 2. C-Clamps: Galvanized steel; 1/2" rod size; approx. 70 pounds per 100 units.
 - 3. I-Beam Clamps: Galvanized steel, 1-1/4" by 3/16" stock; 3/8" cross bolt; flange width 2"; approx. 52 pounds per 100 units.
 - 4. One-hole Conduit Straps: For supporting metal conduit through 3/4" galvanized steel; approx. 7 pounds per 100 units.
 - 5. Two-hole Conduit Straps: For supporting metal conduit above 3/4" galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.
 - 6. Hexagon Nuts: For 1/2" rod size; galvanized steel; approx. 4 pounds per 100 units.
 - 7. Round Steel Rod: Galvanized steel; 1/4" dia.; approx. 12.2 pounds per 100 feet, 3/8" dia.; approx. 29.3 pounds per 100 feet, 1/2" dia.; approx. 67 pounds per 100 feet.
 - 8. Offset Conduit Clamps: For supporting 2" rigid metal conduit; galvanized steel; approx. 200 pounds per 100 units.
 - 9. 2-Piece strut strap, appropriate size, and type for type of conduit being installed. 1-piece straps are prohibited.
 - 10. Minerallac straps sized appropriately for the conduit installed. Drilling out the attachment hole is prohibited. Use proper size hardware for attachment per the UL listing.
 - 11. 7/8" and 1-3/4" slotted channel shall be sized appropriately per the manufacturer's specifications for weight distribution. All feeder conduit racks shall be 1 3/4" minimum.
 - 12. Cable ties shall be Type 2S and 21S. Install in accordance with Section 330.30(A) of the NEC.
- C. Provide anchors of types, sizes, and materials required and having the following construction features:

1. Expansion Anchors: 1/2"; approx. 38 pounds per 100 units.
 2. Toggle Bolts: Springhead; 3/16" by 4"; approx. 5 pounds per 100 units.
 3. Concrete anchors: Anchors used for attaching 1/4" rod shall be Hangermate one-piece concrete screw with internal threads or equal. Follow manufacturers installation specifications for proper installation.
 4. Concrete Anchors: Anchors used for attaching 3/8" and 1/2" rod shall Lok Bolt Sleeve anchor type [Dewalt 05815S-PWR and 05825S-PWR] or approved equal. Follow manufacturers technical Data for weight limitations and installation specifications for proper installation.
 5. Drop-in type anchors shall be used only in vertical concrete walls. Hollow wall anchors shall be used in hollow CMU walls. Anchor shall be installed with manufacturer approved set tool.
- D. Provide sleeves and seals of types, sizes, and materials required, and having the following construction features:
1. Provide factory-assembled, watertight wall and floor seals suitable for sealing around conduit, pipe or tubing passing through concrete floors and concrete block walls. Construct with steel sleeves, malleable-iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps and cap screws.
- E. Provide U-channel strut system for supporting electrical equipment, 16-gauge hot-dip galvanized steel of sizes required; construct with 9/16" dia. holes, 8" o.c. on top surface, and with the following fittings which mate and match with U-channel:
- Fixture hangers
 - Channel hangers
 - End caps
 - Beam clamps
 - Wiring stud
 - Rigid conduit clamps
 - Conduit hangers
 - U-bolts

PART 3 - EXECUTION

3.1 INSTALLATION OF SUPPORTING DEVICES

- A. Install hangers, anchors, sleeves, and seals as indicated in accordance with manufacturer's published instructions and with recognized industry practices to ensure supporting devices comply with the requirements of the NEC, NECA, and ANSI/NEMA for installation of supporting devices.
- B. Coordinate with other electrical work, including outlet box, raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- C. Install hangers, supports, clamps, and attachments to support conduit and outlet boxes properly from building structure. Arrange for grouping of parallel runs of horizontal

conduits to be supported together on trapeze-type hangers where possible. Install supports with maximum spacings indicated.

- D. Tighten sleeve seal nuts until sealing grommets have expanded to form watertight seal.

END OF SECTION 260529

SECTION 260533 - RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SCOPE OF WORK

- A. Run all conduit concealed, except conduit may be run exposed in mechanical rooms, locations where specifically indicated, and spaces with exposed construction as approved by the Architect.
- B. Provide a conduit system complete with fittings and hangers as specified herein and as required by the NEC. Run all electrical wiring systems above 24 Volts in conduit unless specifically indicated otherwise.
- C. Install conduit as a complete system without wiring and continuous from outlet to outlet and from fitting to fitting, mechanically and electrically connected to all boxes, fittings, and wireways, and grounded in accordance with the NEC.
- D. Cap ends of all conduit promptly upon installation with plastic pipe caps. Caps shall remain until wiring is ready to be installed. Taping the ends of conduits is not acceptable.
- E. Size conduit to equal or exceed the minimum requirements of the NEC (except where sizes are specifically indicated on the drawings and in these specifications).
- F. Verify exact swing of doors, prior to installing conduit for switches. Coordinate switches with the Architect's plans, change orders, addenda, and job site differences and make the necessary adjustments to avoid conflicts at no additional cost.
- G. Coordinate the routing of conduit with other trades to avoid conflicts with structural members, piping, ductwork, and other job site conditions.
- H. When PVC conduit is used below grade, it shall be glued together in such a manner so as to make it watertight.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Minimum size conduit shall be 1/2". Use larger sizes as required by the NEC to accommodate the number and sizes of wires contained therein.
- B. Conduit concealed in walls or above ceilings shall be rigid (GRS), electrical metallic tubing (EMT), or intermediate metallic conduit (IMC). Flexible conduit may be used above accessible ceilings only.
- C. Conduit installed below grade and under concrete floors and slabs shall be Schedule 40 PVC, unless otherwise indicated. No conduits shall be embedded horizontally within the concrete slabs. Conduit run vertically through concrete shall be GRS and no portion of conduit radius or elbow shall be installed and/or visible above finished concrete slab. Where GRS conduits turn up inside a wall cavity, it shall be converted to EMT at 6" above the top of the concrete slab. No conduits shall be installed in the concrete masonry unit (CMU) wall cells with structural rebars. All metal (GRS and IMC) conduits and elbows installed in earth shall be painted with two coats of bitumastic paint.
- D. GRS, EMT and IMC shall be UL approved, hot-dip, high-strength, galvanized steel.
- E. Rigid PVC conduit shall be Schedule 40 (or Schedule 80 if required by the NEC), extruded from high-grade PVC compound and shall be light gray in color. Rigid PVC conduit shall be UL approved for direct burial and concrete encasement.
- F. Flexible conduit shall be galvanized, continuous spiral, single strip type. In areas subject to moisture (such as kitchens), and where specifically indicated, flexible conduit shall have a plastic covering in accordance with NEC Article 350. Fittings shall be standard UL approved with ground connector. Watertight connectors shall be used with plastic-covered conduit. All flexible conduit installed in outdoors and kitchens shall be plastic covered. The maximum length for flexible conduit is 72" unless as otherwise indicated. Liquid tight flexible metal conduit is prohibited where subject to physical damage and areas where ambient and conductor temperature exceed the approved operating temperature. Cable ties used to support LFMC shall be type 2S or 21S.
- G. Conduit may not be run in the flutes of metal roof decking and may not be attached to any part of metal roof decking.
- H. Bury conduit run below grade a minimum of 24" below finished grade or so the top of the conduit is 6" below the bottom of the concrete slab if run underneath concrete unless indicated or required to be deeper. Increase the burial depth as required so that no part of the conduit radius is within the concrete slab where conduits turn vertical. Coordinate conduit routings and depths with all other trades and all existing underground utilities.
- I. Empty or spare conduits stub-ups shall be capped with a threaded cap.

- J. In areas classified as hazardous, the conduit coupling shall be below concrete slab and a single section of GRS conduit may be installed up to 18" A.F.F. to accept the required seal fitting.

2.2 FITTINGS

- A. All conduit entering or leaving panelboards, cabinets, outlet boxes, pull boxes, or junction boxes shall have lock nuts and bushings, except provide insulated throat connectors on EMT conduit 3/4" and 1". Rigid steel conduit shall have a lock nut both inside and outside of the enclosure entered. Install bushings on the ends of IMC conduit and EMT conduit larger than 1". Insulating bushings shall be OZ Type A for GRS and IMC, and Type B for EMT. Conduit entering enclosures through concentric knockouts shall have grounding-type bushings with copper bond wire to enclosure.
- B. Provide expansion fittings where conduits cross building expansion joints. Expansion fittings shall be OZ Type AX with OZ Type BJ bonding jumper. See Architectural drawings for location of expansion joints.
- C. Fittings for rigid conduit shall be threaded type, except where IMC changes to EMT above floor slab, fittings shall be threadless type.
- D. Fittings for EMT shall be UL-approved, steel set screw couplings.
- E. Conduits entering service enclosures (panelboards, disconnect switches, switchboards, motor control centers, etc. used as service entrance equipment) shall be provided with specification grade, insulating, grounding type bushings. Grounding bushing shall be bonded together and bonded to the service grounding bus.

2.3 JUNCTION BOXES

- A. Use junction boxes on exposed conduit work for changes in direction of conduit runs and breaking around beams and columns.
- B. Furnish covers and gaskets with the junction boxes where installed in damp or wet locations.
- C. Label all junction and pull box covers indicating the circuits contained therein in a manner that will prevent unintentional interference with circuits during testing and servicing. For example: "HE1-13." See Specification Section 260534 for labeling requirements.

2.4 PIPE SLEEVES

- A. Provide pipe sleeves where conduits larger than 2" pass through walls. Contractor shall be responsible for proper and permanent location. Conduit shall not be permitted to pass through footings, beams, or ribs, unless indicated and/or approved. Coordinate pipe sleeve locations with all other trades affected.

- B. Install pipe sleeves and properly secure in place with grout where conduit passes through masonry or concrete and at all fire-rated assemblies. Pipe sleeves shall be of a sufficient diameter to provide approximately 1/4" clearance all around the conduit. Fill void between conduit and sleeve with mineral wool to prevent sound transmission. Pipe sleeves in foundation walls shall be cast iron, 2" larger in diameter than the conduit installed. Pipe sleeves in walls, floors, and partitions shall be Schedule 40 black steel pipe. Extend sleeves above floor at least 1", pack space around conduit with fireproof material, and make watertight. Pipe sleeves passing through firewalls, smoke partitions, fire partitions, or floors shall be sealed with a UL-rated system appropriate for the specified rating.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install conduit concealed in walls, below floor slabs, and above ceilings, except conduit may be run exposed in mechanical and electrical equipment rooms. Maintain a minimum clear distance of 6" from parallel runs of flues, steam, or hot water pipes. Do not run conduit horizontally in concrete slabs.
- B. Use flexible conduit (minimum 18" in length, maximum 72" in length) for connections to all motors, dry-type transformers, water heaters, and any equipment subject to vibration.
- C. Group conduit so it is uniformly spaced, where straight and at turns. Make bends and offsets (where unavoidable) with a hickey or bending machine.
- D. Ream GRS and IMC conduit after threading to remove all burrs.
- E. Securely fasten conduit to outlets, junction boxes, and pull boxes to affect firm electrical contact. Join conduit with approved couplings. Running threads are not allowed.
- F. Exercise care to avoid condensation pockets in the installations. Keep conduit, fittings, and boxes free from foreign matter of any kind, before, during, and after installation.
- G. Do not use EMT below grade, outdoors and in wet locations.
- H. Support exposed runs of conduit in accordance with N.E.C. 342, 344, 348, 350 and 358 and parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings with right angle turns consisting of fittings or symmetrical bends. Support conduit within one foot of all changes in direction and on each side of the change.
- I. Supports shall be wall brackets, trapeze, strap hanger, or pipe straps, secured to hollow masonry with toggle bolts or Hollow wall anchors; to brick and concrete with expansion Anchors; to metal surfaces with machine screws; and to wood with wood screws. Overhead conduits supported by threaded rod from concrete shall be those listed in the approved hanger specification and conform to the manufactures technical data and installation specifications.

- J. Use explosive drive equipment to make connections where the use of this equipment is beneficial and is subject to strict compliance with safety regulations and approved by the Owner.
- K. Wooden plugs inserted in masonry and the use of nails as fastening media are prohibited.
- L. Do not support conduit from lay in tile ceilings grids, ceiling grid hangers, or lay on ceiling tiles.
- M. Prime conduit with a surface conditioner "GalvaGrip" or approved equal and paint to match the surface on which attached. Conduit installed in mechanical and electrical rooms need not be painted.
- N. Install and support conduit from the underside of the upper chord in bar joist construction.
- O. Do not support conduit from or attach outlet or junction boxes to metal roof decks.
- P. Do not run conduit in the cavity of exterior walls between brick and CMU.
- Q. Where conduits penetrate through non-fire-rated floors, ceiling, or walls, seal the conduits with a fire-resistant caulk to prevent liquids and insects from passing through.
- R. Where conduits penetrate through fire-rated floors, ceiling, or walls, provide a UL-Listed, water-resistant firestop material with a rating equal to or greater than the rating of the penetrated floors, ceilings, or walls.
- S. Metal conduit and elbows installed in earth shall be painted with two coats of bitumastic paint.
- T. All conduit runs entering the building from outdoors shall be sealed against moisture migration and condensation by filling with insulating type foam.
- U. Single runs of conduit 1/2" to 1-1/2" in diameter shall be supported by 1/4" round galvanized rod. Single runs of conduit 2" and larger shall be supported by 3/8" round galvanized rod. Single tier conduit racks with conduit 1/2" to 1" and no greater than five shall be supported by 1/4" round galvanized rod. Single tier conduits racks 1-1/4" and larger shall be supported with 3/8" round galvanized rod. All conduit racks larger than a single tier shall be 1/2" minimum round galvanize rod. Conduit and conduit racks shall comply with the manufacturer's supporting limitations.

END OF SECTION 260533

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SECTION 260534 - ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SCOPE OF WORK

- A. Furnish and install all junction boxes of a type and size applicable for use in the location indicated on the drawings and where required by the NEC.
- B. Exercise special care in the location of outlet and junction boxes in order that the hanging or recessing of light fixtures will not be obstructed by piping or ductwork installed by other trades. To this end, coordinate the work with representatives of the other trades involved and by reference to the architectural, structural, mechanical, plumbing and sprinkler drawings.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

- A. Outlet boxes shall be sheet steel, zinc coated, or cadmium plated.
- B. Provide existing and new outlet boxes installed but not used, including data outlets, with blank coverplates matching those provided on adjacent outlets.
- C. Size boxes as follows:
 - 1. Switch and Receptacle Outlet Boxes: Provide single gang outlet boxes 1-1/2" deep unless required to be larger. Provide extra deep boxes where required.
 - 2. Fixture Outlets in Ceiling: 4" octagonal, minimum. Where required to accommodate larger conduit or a larger number of wires: 4-11/16" by 2-1/8" deep.
 - 3. One-piece multi-gang boxes for use where two or more switches or receptacles are located side by side: 2-1/8" deep. Sectionalized boxes will not be allowed.
 - 4. Where larger size boxes are required or called for, they shall be similar in all other respects to the types specified above.

- D. Light fixture outlet boxes, where fixtures are to be mounted on the box, shall have suitable studs and supports for carrying the weight of the fixture. Increase box depth, as required, for additional wires and conduits.
- E. Boxes in new finished walls shall be flush mounted and have flush coverplates and proper type extension rings or plaster covers where required. Provide blank Series 302 stainless-steel coverplates on boxes not scheduled to receive coverplates of an otherwise specified type. If an extension ring is used to extend a junction box, one extension ring shall be used per box.
- F. Provide boxes located above suspended ceilings with galvanized steel covers, with openings or knockouts as required for type of service.
- G. Boxes installed in concrete construction shall be galvanized concrete type at all locations except where conduit or cast-iron boxes are required for watertight or vaportight outlets.
- H. Boxes installed in the floor shall be as specified on the drawings and shall comply with the requirements indicated on the drawings. Provide brass carpet flanges where boxes are installed in carpeted areas.

2.2 PULL BOXES AND JUNCTION BOXES

- A. Install pull boxes and junction boxes where required for changes in direction, at junction points, and where needed to facilitate wire pulling.
- B. Size boxes in accordance with the requirements of the NEC.
- C. Boxes shall be constructed of 12-gauge minimum hot-rolled sheet steel and shall be hot-dip galvanized inside and outside to match the conduit. Boxes shall have removable covers.
- D. Label the front face of the cover on each box with indelible black marker indicating the number of each circuit contained in or running through the box. In areas where exposed construction is the final finished condition and conduit and junction boxes are called out to be painted, label the inside face of the covers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Check all door swings and coordinate with all furniture, built-in equipment, and cabinetry prior to roughing-in conduit and boxes for switches, receptacles, and auxiliary system devices. Make necessary adjustments in the location of same to avoid conflicts as approved by the Architect and at no additional cost to the Owner.
- B. Install all outlet boxes flush with wall or ceiling finish.

- C. Mounting heights of outlets in tile or unplastered masonry shall be varied plus or minus to the nearest block joint so the bottom or top of the box rests on a block joint. Install outlet boxes in the same space at the same height above finished floor unless indicated or required to be otherwise.
- D. Check the location of all wall outlets prior to roughing-in conduit to verify that the outlet will clear any wall fixtures, shelving, worktables, etc., that exist or will be installed. Make necessary adjustments in the location of wall outlets to avoid conflicts as approved by the Architect and at no additional cost to the Owner.
- E. Prior to roughing-in conduit, coordinate with other trades and the Owner regarding all equipment requiring electrical connections. Required adjustments to the conduit and wire sizes shall be made at no additional cost.
- F. Conduit installation shall be rigid and secure, and, where necessary, angle iron (1" by 1" by 1/4" or larger) shall be provided to facilitate adequate mounting.
- G. Install electrical boxes and fittings in accordance with manufacturer's published instructions, applicable requirements of the NEC and NECA "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.
- H. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
- I. Provide "weatherproof-while-in-use" rated outlet covers for interior and exterior locations exposed to weather or moisture.
- J. Provide knockout closures to cap unused knockout holes where blanks have been removed in panel cans, terminal cabinet backboxes, junction boxes, outlet boxes and pull boxes.
- K. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.
- L. Do not install boxes back to back in walls. Provide not less than 6" (150 mm) separation. Thru-the-wall boxes may not be used.
- M. Position recessed outlet boxes accurately to allow for surface finish thickness.
- N. Fasten electrical boxes firmly and rigidly to substrates or structural surfaces to which attached or solidly embed electrical boxes in concrete or masonry.
- O. Subsequent to installation of boxes, protect boxes from construction debris and damage.
- P. Upon completion of installation work, properly ground all electrical boxes.
- Q. Do not mount boxes to metal roof decking.

END OF SECTION 260534

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SECTION 260536 - CABLE TRAYS

PART 1 - GENERAL

1.1 SUMMARY

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Scope of Work:
 - 1. Provide all labor, material, tools, scaffolds, erection equipment, services and supplies to fabricate, install, connect and adjust the cable tray and racks as called for in these Specifications and as indicated on the Contract Drawings.
- C. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

PART 2 - PRODUCTS

2.1 CABLE TRAY: WIRE MESH

- A. Cable Tray: The cable tray and all fittings and accessories shall affect a complete structural system in the form of a rigid mechanical tray of compatible material and design, functional to support all cables.
- B. Description: Carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent and surface treated after manufacture. The finish shall be Electrodeposited Zinc Plating; ASTM B 633. Tray width shall be 12 inches.
- C. Fittings and Accessories:
 - 1. Provide manufacturers rung caps on all rungs. Provide gray-colored rung caps where exposed to public's view.
 - 2. Provide the manufacturer's recommended fittings including bushings, spacers, wall brackets, ceiling hanger brackets, support clips, mounting angles, sleeves, couplings, junctions, bends, elbows, vertical and horizontal tees, crosses, wall end connectors, pivot connectors, splice connectors, bushing connectors, angle connectors, offset connectors, wall plate connectors, tray to box connectors, tray to wall connectors, fasteners, offsets, threaded rod, and all other components to make the system work.
- D. Acceptable Manufacturers:
 - 1. Legrand
 - 2. B-Line Systems

- 3. MP Husky
- 4. Mono Systems

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation requirements in this specification apply to both cable tray and cable rack
- B. Install in accordance with the manufacturer's installation instructions and recommendations using the manufacturer's recommended fittings and accessories for system support, splices, tees, elbows, bends, intersections, and for all transitions up, down and around obstructions.
- C. Install as a complete system as indicated on the drawings.
- D. Ensure electrical continuity of the system and adequate support for the cables. Bond to make electrically continuous. Specific hardware may be required as required by the manufacturer.
- E. Where physical discontinuity is necessary, cables shall be supported over the length of the discontinuity by alternate means (including conduits, hangers, clips, brackets, hooks, distribution rings, etc.). The ends of the cable tray or rack shall be electrically bonded together over each length of discontinuity.
- F. Cable tray shall be bonded together to make electrically continuous. Bond the cable tray to the Telecommunications Grounding busbars in the communications closets.
- G. Do not use copper fittings or hardware to connect bonding conductors to aluminum cable trays.
- H. Support cable trays and cable racks at splices, tees, elbows, bends, intersections, transitions in accordance with manufacturer's recommendations. The supporting mechanisms shall be sufficiently spaced to support the weight of the cable trays and cable racks for their maximum capacity rating.
- I. Install the cable tray and cable rack systems to be free of sharp edges, burrs, or projections.
- J. All metal shall be protected against corrosion.
- K. Provide manufacturer's rung caps on rung ends unless rung ends are designed by the manufacturer to protect the cable and the installer from harm without rung caps. Where rung caps are necessary, provide gray-colored rung caps where exposed to public view.
- L. For cable racks manufactured without sides, mount attachable "L" brackets at all tees, elbows, bends, intersections and for all transitions up, down and around obstructions at a minimum spacing of every other rung. Install brackets to insure adequate containment and support for all cables.

- M. Route cable tray parallel and perpendicular to walls and ceiling.
- N. Support ladder style cable rack from overhead. Do not use wall support brackets.

END OF SECTION 260536

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**SECTION 260573 - SHORT-CIRCUIT/COORDINATION STUDY/ARC FLASH
HAZARD ANALYSIS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SCOPE OF WORK

- A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer or a consulting engineering firm who is regularly engaged in performing such studies.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E-Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 and NFPA70E.
- C. The contractor shall coordinate with the power company and use the existing information (maximum fault current, service amps capacity, impedance, and voltage) provided by the power company to perform the Short Circuit, Coordination and Arc Flash Study to produce the required Arch Flash Labels and Protective Device Settings.
- D. The scope of the studies shall include the following:
 - 1. All new power distribution equipment supplied by the equipment manufacturer under this contract and existing 2000-amp main circuit breaker in the existing main distribution switchboard (MDS).
 - 2. The following mechanical equipment:
 - a. RTU-1, RTU-2, and RTU-3.

1.3 REFERENCES

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
6. IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

C. The National Fire Protection Association (NFPA)

1. NFPA 70 - National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.4 SUBMITTALS FOR REVIEW/APPROVAL

- A. Submit the power system study along with the electrical equipment submittals for review by the Engineer. The electrical power equipment submittals will not be reviewed until the power system study has been received, reviewed, and accepted by the Engineer. Any changes to equipment dictated by the results of the power system study shall be submitted to the Engineer for review prior to any changes being made.

1.5 SUBMITTALS FOR CONSTRUCTION

- A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. Three (3) bound copies of the complete final report shall be submitted.
- B. The report shall include the following sections:
1. Executive Summary
 2. Descriptions, purpose, basis and scope of the study
 3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties
 4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection
 5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout
 6. Details of the incident energy and flash protection boundary calculations

- 7. Recommendations for system improvements, where needed.
 - 8. One-line diagram
- C. Arc flash labels shall be provided in hard copy only.

1.6 QUALIFICATIONS

- A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.
- B. The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer or a consulting engineering firm registered to do business in the Commonwealth of Virginia.
- C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.
- D. The equipment manufacturer or approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least five actual arc flash hazard analysis it has performed in the past 2 years.

1.7 COMPUTER ANALYSIS SOFTWARE

- A. The studies shall be performed using the latest revision of the SKM Systems Analysis Power*Tools for Windows (PTW) software program or equal.

PART 2 - PRODUCT

2.1 STUDIES

- A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer or a consulting engineering firm.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

2.2 DATA COLLECTION

- A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings.

- B. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner and/or Contractor.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

- A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard.
- B. Transformer design impedances shall be used when actual test impedances are not available.
- C. Provide the following:
 - 1. Calculation methods and assumptions
 - 2. Selected base per unit quantities
 - 3. One-line diagram of the system being evaluated
 - 4. Source impedance data, including electric utility system and motor fault contribution characteristics
 - 5. Tabulations of calculated quantities
 - 6. Results, conclusions, and recommendations.
- D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
 - 1. Distribution panelboard.
 - 2. Branch circuit panelboards
 - 3. Any other location likely to be served while energized.
- E. 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.
- F. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to proposed short-circuit ratings.
 - 2. Adequacy of panelboard bus bars to withstand short-circuit stresses.
 - 3. Evaluate conductors and busways for ability to withstand short-circuit heating.
 - 4. Identify any existing circuit protective devices improperly rated for the calculated available fault current.
 - 5. Tabulate all evaluation results.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

- A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

- B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.
- C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
- D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- E. Plot the following characteristics on the TCC graphs, where applicable:
 - 1. Electric utility's overcurrent protective device
 - 2. Medium voltage equipment overcurrent relays
 - 3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
 - 4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
 - 5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
 - 6. Conductor damage curves
 - 7. Ground fault protective devices, as applicable
 - 8. Pertinent motor starting characteristics and motor damage points, where applicable
 - 9. Pertinent generator short-circuit decrement curve and generator damage point
 - 10. The largest feeder circuit breaker in each applicable panelboard.
- F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.
- G. Provide selective coordination [to 0.01 second for the following systems in accordance with the requirements listed in the following National Electrical Code sections:
 - 1. 620.62 Elevators

2.5 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E.
- B. The flash protection boundary and the incident energy shall be calculated at all locations likely to be served while energized in electrical distribution system, including but not limited to panelboards, disconnect switches, and splitters where work could be performed on energized parts.
- C. The Arc-Flash Hazard Analysis shall include any location likely to be served while energized in 480 volt, 240 volt and 208 volt systems fed from transformers.
- D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².

- E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
- F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating.
- G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
 - 2. Fault contribution from synchronous motors should be decayed to match the actual decrement of each as closely as possible.
- H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
- J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584 Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.
- L. Calculate shock hazard approach boundaries (limited approach boundary and restricted approach boundary) for each equipment location.
- M. Provide recommendations to reduce arc-flash hazard energy and exposure.

- N. Coordinate with manufacturers/suppliers of the electrical equipment.

2.6 REPORT SECTIONS

- A. Input data shall include, but not be limited to the following:

1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
3. Reactor data, including voltage rating, and impedance.
4. Generation contribution data, (Utility), including short-circuit reactance ($X''d$), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
5. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

- B. Short-Circuit Output Data shall include, but not be limited to the following reports:

1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a. Voltage
 - b. Calculated fault current magnitude and angle
 - c. Fault point X/R ratio
 - d. Equivalent impedance
2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a. Voltage
 - b. Calculated symmetrical fault current magnitude and angle
 - c. Fault point X/R ratio
 - d. Calculated asymmetrical fault currents
 - 1) Based on fault point X/R ratio
 - 2) Based on calculated symmetrical value multiplied by 1.6
 - 3) Based on calculated symmetrical value multiplied by 2.7
 - e. Equivalent impedance
3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable 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

C. Recommended Protective Device Settings:

1. Phase and Ground Relays:

- a. Current transformer ratio
- b. Current setting
- c. Time setting
- d. Instantaneous setting
- e. Recommendations on improved relaying systems, if applicable.

2. Circuit Breakers:

- a. Adjustable pickups and time delays (long time, short time, ground)
- b. Adjustable time-current characteristic
- c. Adjustable instantaneous pickup
- d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations

- 1. Arcing fault magnitude
- 2. Protective device clearing time
- 3. Duration of arc
- 4. Arc flash boundary
- 5. Working distance
- 6. Incident energy
- 7. PPE Category
- 8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

- A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study.
- B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

- C. Notify Owner in writing of any required major equipment modifications.

3.2 ARC FLASH WARNING LABELS

- A. The contractor shall provide a 4 in. x 6 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
- C. The label shall include the following information, at a minimum:
 - 1. Location designation
 - 2. Nominal voltage
 - 3. Flash protection boundary
 - 4. Incident energy and associated working distance
 - 5. Engineering report number, revision number and issue date.
- D. Labels shall be machine printed, with no field markings.
- E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 - 1. For each 480 and applicable 208-volt panelboard, one arc flash label shall be provided.
 - 2. For each disconnect switch, one arc flash label shall be provided
- F. Labels shall be field installed by the electrical sub-contractor under the Startup and Acceptance Testing contract portion.

END OF SECTION 260573

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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, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Indoor occupancy sensors.
 - 2. Wall Switch Occupancy Sensors – Small Areas
 - 3. Wall Switch Occupancy Sensors – Large Areas
 - 4. Line Voltage Occupancy Sensors
- B. Related Sections include the following:
 - 1. Division 26 Section "Wiring Devices and Device Plates" for wall-box dimmers and manual light switches.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation details for occupancy and light level sensors.
 - 1. Provide scaled plan layouts of all occupancy sensor locations based upon the manufacturer's suggested layout for their equipment in full compliance with these specifications.

- a. Show sensor type being supplied for each sensor location and the area of coverage for each sensor.
- 2. Interconnection diagrams showing field-installed wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in Emergency section of the operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.
- B. Occupancy Sensing Detection Technology
 - 1. The occupancy sensor system shall sense the presence of human activity within the covered space and fully control the on/off function of the lighting.
 - 2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies will not be accepted.
 - 3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.
 - 4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) will not be acceptable.
 - 5. All sensing technologies shall be acoustically passive meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies will not be accepted.
- C. Occupancy Sensor Operation Requirements
 - 1. Sensors shall offer a minimum on timer of at least 15 minutes, in order to prevent cycling of lamps before they have burned in accordance with the lamp manufacturer’s minimum recommended time period. This timer shall be in addition to the regular occupancy time delay that keeps lights on after last detected occupancy. User shall be able to disable/enable and change the value of this timer.
 - 2. Sensors shall utilize an occupancy time delay that keeps lights on after last detected occupancy. Factory default setting of the occupancy time delay shall be 10 minutes. Sensors with a longer factory default setting will not be permitted.

3. Manual adjustment to the occupancy time delay so as to increase it shall be accommodated, but will not be allowed unless approved by the Architect/Owner.
4. All sensors shall be factory calibrated for optimum performance for its installed PIR lens, and shall not require initial or subsequent field adjustment of detection sensitivity.
5. All sensor setting adjustments shall be digital and made using a push-button. Dip switches, analog dials, and/or the need for tools of any kind will not be accepted.
6. The contractor is responsible for a complete and functional system in accordance with all applicable local and national codes.

1.6 COORDINATION

- A. 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 system, and partition assemblies.
- B. Sensors are shown schematically only. Contractor shall provide an adequate quantity of sensors as needed to completely cover the space being controlled. If the [Architect/Engineer] deems coverage to be unacceptable, contractor shall provide additional sensors as required to satisfy Architect at no additional cost.

1.7 MISCELLANEOUS REQUIREMENTS

- A. All steps in sensor manufacturing process will occur in the USA; including population of all electronic components on circuit boards, soldering, programming, wiring, and housing. Manufacturing facility must be ROHS compliant.
- B. In high humidity or cold environments, the sensors shall be conformably coated and rated for condensing humidity and -40 degree Fahrenheit (and Celsius) operation.
- C. All applicable products must be UL Listed.
- D. Sensors shall carry a full 5-year warranty.

1.8 MANUFACTURER AND SUBSTITUTIONS

- A. The basis of design for the products specified herein is those manufactured by Sensor Switch, Inc.
- B. Substitutions may be submitted for review. All substitutions must clearly identify any and all exceptions to the specifications with a detailed explanation as to the exception. If the substitution is approved, the contractor shall bear the responsibility of a fully functional system to the Architect/Owner.

PART 2 - PRODUCTS

2.1 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Lighting.
 2. Leviton Mfg. Company Inc.
 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 4. TORK.
 5. Watt Stopper (The).
 6. Sensor Switch.
 7. Crestron.
- B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit or line voltage.
1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time-delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes. Shall also be capable of operating as a vacancy sensor.
 2. Sensor Output: Contacts rated to operate the connected relay complying with UL 773A. Sensor shall be powered from the relay unit.
 3. Relay Unit (if required): Dry contacts rated for 20-A ballast load at 120 and 277-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 6. Bypass Switch: Override the on function in case of sensor failure.
 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); keep lighting off when selected lighting level is present.
 8. Provide single or 2-pole switches as required/indicated on drawings.
- C. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be 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 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.2 WALL SWITCH OCCUPANCY SENSORS – SMALL AREAS

- A. Sensor shall provide wall-to-wall PIR detection such that small hand motions are detected out to 20 ft (6.10 m).
- B. In areas with periodic or permanent obstruction to a sensor's field of view, sensors that utilize dual technology (PIR/Microphonics) detection shall be used.
- C. Sensors shall be capable of switching 120 VAC and 277 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC and ¼ HP motor loads.
- D. Sensor shall recess into single gang switch box and fit a standard GFI opening.
- E. Sensor shall meet NEC grounding requirements by providing a dedicated ground connection and intrinsically grounding through its mounting strap.
- F. Sensor shall not require a neutral connection regardless of number of poles and/or detection technology.
- G. Sensor shall not allow any leakage of current to pass to the load when sensor is in the unoccupied (off) condition. Sensor shall not require a minimum load to be connected in order to function.
- H. Sensor shall have optional features available for photocell/daylight override, vandal resistant lens, low temperature/high humidity operation.
- I. All sensor settings, including time delay and photocell settings shall be digital and accessible for adjustment via a push-button without requiring removal of cover plate or tools of any kind.
- J. Wall Switch sensors shall have field programmable adjustments for selecting operational modes, occupancy time delays, minimum on time, and photocell set-point as applicable.
 1. All models shall be capable of both Auto-On and Manual On operation.
 2. All models shall be capable of a "Reduced Turn On" operation where the initial PIR turn on level is higher in order to eliminate PIR from reflective surfaces from being detected. PIR shall be returned to normal levels upon initial PIR detection.
 3. All models shall have a "Predictive Off" mode where user can manually turn the lights off when leaving the room and still have them come on automatically when they return to space.

- K. All models shall be capable of disabling override switch.
- L. Sensors shall be the following Sensor Switch model numbers or approved equals:
 - 1. WSX PDT SA (PIR/Microphonics, Manual On by default)

2.3 WALL SWITCH DIMMING OCCUPANCY SENSORS – SMALL AREAS

- A. Sensor shall provide wall-to-wall PIR detection such that small hand motions are detected out to 20 ft (6.10 m).
- B. In areas with periodic or permanent obstruction to a sensor's field of view, sensors that utilize dual technology (PIR/Microphonics) detection shall be used.
- C. Sensors shall be capable of switching 120 VAC and 277 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC [and ¼ HP motor loads.
- D. Sensor shall recess into single gang switch box and fit a standard GFI opening.
- E. Sensor shall meet NEC grounding requirements by providing a dedicated ground connection and intrinsically grounding through its mounting strap.
- F. Sensor shall not require a neutral connection regardless of number of poles and/or detection technology.
- G. Sensor shall not allow any leakage of current to pass to the load when sensor is in the unoccupied (off) condition. Sensor shall not require a minimum load to be connected in order to function.
- H. Sensor shall have optional features available for photocell/daylight override, vandal resistant lens, low temperature/high humidity operation.
- I. All sensor settings, including time delay and photocell settings shall be digital and accessible for adjustment via a push-button without requiring removal of cover plate or tools of any kind.
- J. Wall Switch sensors shall have field programmable adjustments for selecting operational modes, occupancy time delays, minimum on time, and photocell set-point as applicable.
 - 1. All models shall be capable of both Auto-On and Manual On operation.
 - 2. All models shall be capable of a "Reduced Turn On" operation where the initial PIR turn on level is higher in order to eliminate PIR from reflective surfaces from being detected. PIR shall be returned to normal levels upon initial PIR detection.
 - 3. All models shall have a "Predictive Off" mode where user can manually turn the lights off when leaving the room and still have them come on automatically when they return to space.
- K. All models shall be capable of disabling override switch.
- L. Compatible with 0-10V dimming luminaries

M. Sensors shall be the following Sensor Switch model numbers or approved equals:

1. WSX PDT D SA (PIR/Microphonics, Manual On by default)

2.4 LOW VOLTAGE OCCUPANCY SENSORS

- A. Contractor shall install one or more sensors with PIR coverage areas that cover the entire space and all entrance points.
- B. In areas with periodic or permanent obstruction to a sensor's field of view, sensors that utilize dual technology detection shall be used.
- C. Sensors shall utilize a digital PIR detector (dual element pyro-electric detector) component, so as to provide a high degree of RF immunity.
- D. Sensors shall interconnect with other sensors and power/relay packs with class 2, three-conductor wiring.
- E. Sensors shall operate on 12 to 24 VAC or VDC and consume no more than 5 mA so that up to 14 sensors may be connected to a single power pack.
- F. Upon initial power up, sensors must immediately turn on. Power packs may be wired on the line or load side of local switching and must not exhibit any delays when switch is energized.
- G. Each designated zone shall contain one sensor with a SPDT class 2 auxiliary relay, providing an input to building automation system (BAS) if required. All sensors in designated zone shall communicate to sensor with relay for status to BAS. Sensor relay coil shall energize in the unoccupied state to load share the low voltage current from power pack. Note that power pack must be installed on the Line side of the local toggle switch for auxiliary relay to work properly.
- H. Sensors shall have test mode that temporarily shortens/disable all time delays (e.g., minimum on, occupancy, photocell transition, dimming rates) such that an installer can quickly test operation of sensor. Test mode shall time out and return sensor to normal operation should the installer forget to disable test mode after installation.
- I. Sensors shall have optional features for on/off photocell control, automatic dimming control photocell, high/low occupancy based dimming, and usage in low temperature/high humidity environments.
- J. Sensors shall be the following Sensor Switch model numbers.
 1. CM PDT 10 (PIR/Microphonics, Ceiling Mount, Extended Range)
 2. WV PDT 16 (PIR/Microphonics, Corner Mount, Wide View)
 3. HW13 (PIR, Wall Mount, Hallway View)
 4. CM 6 (PIR, Ceiling Mount, High Bay 360°)

2.5 POWER PACKS

- A. Power packs shall accept and switch 120 or 277 VAC, be plenum rated, and provide class 2 power for up to 14 remote sensors.
- B. Power pack shall securely mount to junction location through a threaded ½ inch chase nipple. Plastic clips into junction box shall not be accepted. All class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
- C. When required by local code, power pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
- D. Power pack shall incorporate a Class 1 relay and an AC electronic switching device. The AC electronic switching device shall make and break the load, while the relay shall carry the current in the on condition. This system shall provide full 20 Amp switching of all load types, and be rated for 400,000 cycles.
- E. Power packs shall be single circuit, or two circuits. Slave packs may be used to control additional circuits. When two circuit power packs, or slave packs are used, the power packs must be wired directly to circuit breaker. Otherwise, power packs may be wired on the line or load side of the local switch.
- F. Power packs shall be the following Sensor Switch models or approved equal:
 - 1. PP20 (Single Pole)
 - 2. PP20 2P (Two-Pole)

2.6 LINE VOLTAGE OCCUPANCY SENSORS

- A. Sensors shall be self-contained and accept Class 1 wiring directly without the use of a power pack.
- B. The installing contractor shall install one or more sensors with PIR coverage areas that cover the entire space and all entrance points. Exact placement and quantity required shall be per manufacturer's best practice recommendations.
- C. In areas with periodic or permanent obstruction to a sensor's field of view, sensors that utilize dual technology (PIR/Microphonics) detection shall be used (as specified in above section 1.1, Occupancy Sensor Technology Requirements).
- D. Sensors shall utilize a digital PIR detector (dual element pyro-electric detector) component, so as to provide a high degree of RF immunity.

- E. Line and load wire connections shall be interchangeable, such that installer cannot make an improper connection to a line/load in a manner that will cause malfunction or damage to the sensor.
- F. Multiple sensors controlling the same load shall be wired in parallel.
- G. For applications requiring independent control of two loads, a sensor with two dual relays shall be required. Each relay shall have independent programmable occupancy time delays.
- H. Dual relay sensors shall have an optional operational mode called “Alternating On” where when during unoccupied periods, one relay is always left closed (thus one load is always on). The particular relay that is left closed alternates each cycle so that the aging of the connected lamps is even.
- I. Sensors shall be capable of switching both 120 VAC and 277 VAC and run off of 50/60 Hz power. A version capable of switching 347 VAC shall also be available. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor load.
- J. Specific sensors capable of switching 5 Amps of two phase power (208/240 or 480 VAC) shall be available. These sensors shall always simultaneously switch both phases as per NEC guidelines.
- K. Wall mounted sensors must be installed at 7 to 8 feet above the floor. Single and two circuit units shall be available.
- L. High bay sensors controlling HID Bi-Level must incorporate a “Start to High” timer on initial power up to provide full light output for up to 20 minutes to prevent shortened lamp life.
- M. Sensors shall have test mode that temporarily shortens/disable all time delays (e.g., minimum on, occupancy, photocell transition, dimming rates) such that an installer can quickly test operation of sensor. Test mode shall time out and return sensor to normal operation should the installer forget to disable test mode after installation.
- N. Sensors shall have optional features for on/off photocell control, automatic dimming control photocell, high/low occupancy based dimming, and usage in low temperature/high humidity environments.
- O. Sensors shall be the following Sensor Switch models or approved equal:
 - 1. CMR PDT 10 / CMR PDT 10 2P (Extended Range 360°, PIR/Microphonics Dual Technology, Ceiling Mount – Single / Two-Pole)
 - 2. WVR 16 / WVR 16 2P (Wide View, PIR, Wall Mount – Single / Two-Pole)
 - 3. WVR PDT 16 / WVR PDT 2P (Wide View, PIR/Microphonics Dual Technology, Wall Mount – Single / Two-Pole)
 - 4. CMR 6 / CMR 6 2P (High Bay 360°, PIR, Ceiling Mount – Single / Two-Pole)

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. 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.
- B. 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.
- C. Provide no less quantity of sensors as shown on plans but add additional sensors when required to fulfill coverage requirement for the specific model of the sensor provided.
- D. Provide occupancy sensor operation that requires movement to activate luminaires controlled and turns luminaires off after a set time of inactivity.
- E. Provide vacancy sensor operation that requires manual control to activate luminaires and turns luminaires off after a set time of inactivity.

3.2 WIRING INSTALLATION

- A. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power limited conductors according to conductor manufacturer's written instructions.
- B. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- C. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections
 - 1. Operational Test: After installing 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.

- D. Lighting control devices will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.4 ADJUSTING

- A. For occupancy sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 260923

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SECTION 262200 - DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SCOPE OF WORK

- A. Extent of transformer work is indicated by drawings and schedules.
- B. Types of transformers specified in this Section include K4 rated dry-type transformers.
- C. Electrical wiring connections for transformers are specified in applicable Division 26 Sections.

1.3 QUALITY ASSURANCE

- A. Comply with the requirements of the NEC, as applicable to installation and construction of electrical power distribution transformers.
- B. Comply with applicable portions of NEMA TR1 and DOE 2016 minimum Standards for power distribution transformers.
- C. Comply with applicable requirements of ANSI C57-Series pertaining to power distribution transformers.
- D. Comply with applicable requirements of ANSI/UL 506, "Safety Standard for Specialty Transformers." Provide power distribution transformers and components which are UL-Listed and labeled.
- E. Comply with applicable requirements of NESC (ANSI C2) pertaining to indoor and outdoor installation of transformers.

PART 2 - PRODUCTS

2.1 POWER DISTRIBUTION TRANSFORMERS

- A. Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation. All transformers shall be products of a single manufacturer.
- B. Dry-type Distribution Transformers: Provide factory-assembled, K4-rated, air-cooled, dry-type distribution transformers where shown; of sizes, characteristics, and rated capacities indicated; 3-phase; 60 Hz, 30kV BIL, 4.0% nominal impedance, copper windings, with 480-Volts delta connection primary and 208/120-Volts secondary wye connected. Provide primary winding with six 2-1/2% taps; two above and four below primary rated voltage. Transformers 15kVA and above shall be rated for 150°C temperature rise above 40°C ambient except K4-rated transformers shall be rated for 115°C temperature rise above 40°C ambient. All insulating materials shall be in accordance with NEMA ST20 Standard for a 220°C UL component recognized insulation system. Limit transformer surface temperature rise to maximum of 65°C. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections and electrical supply raceway terminal connector. Equip terminal leads with connectors installed. Provide wiring connectors suitable for copper wiring. Sound levels shall not exceed the following: 51 to 150kVA = 50 dB. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable NEMA, IEEE, and ANSI standards. Provide transformers with fully enclosed sheet-steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure. Provide transformers suitable for floor or wall mounting as indicated. The transformers shall be listed by UL for the specified temperature rise.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which power distribution transformers and ancillary equipment are to be installed and notify the General Contractor, in writing, of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TRANSFORMERS

- A. Install transformers as indicated, complying with manufacturer's published instructions (including rear ventilation clearances), applicable requirements of the NEC, NESC, NEMA, ANSI, DOE and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.

- C. Connect transformer units to electrical wiring system; comply with requirements of other Division 26 Sections.
- D. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.
- E. Provide 4" thick concrete housekeeping pad under all transformers. Exceed dimensions of transformer by 6" on all sides. Chamfer all exposed edges 1/2".
- F. Keep transformers clean and free from foreign matter of any kind, before, during, and after installation.
- G. Provide sufficient space around transformer for cooling as recommended by the manufacturer. Provide a minimum space of 8" between the transformer and any wall.

3.3 GROUNDING

- A. Provide equipment grounding connections for power distribution transformers as indicated. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounding.

3.4 TESTING

- A. Prior to energization of transformers, check all accessible connections for compliance with manufacturer's torque tightening specifications.
- B. Prior to energization, check circuitry for electrical continuity and for short-circuits. After all wiring is pulled and ready for operation but prior to placing systems in service, conduct insulation resistance tests in all feeder circuits. Measure the insulation resistance between conductors and between each conductor and ground. Make measurements with an instrument capable of making measurements at an applied potential of 500 Volts.
- C. Upon completion of installation of transformers, energize primary circuitry at rated voltage and frequency from normal power source and test transformers, including but not limited to audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units or components and proceed with retesting.
- D. Infrared Scanning: After Substantial Completion, but not more than 60 days from Final Acceptance, perform an infrared scan of each transformer.
 - 1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2. Record of Infrared Scanning: Prepare a certified report that identifies transformer checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. **Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.**

1.2 SCOPE OF WORK

- A. Extent of panelboard, load center, and enclosure work, including cabinets and cutout boxes, is indicated by drawings and schedules.
- B. Refer to other Division 26 Sections for cable/wire, connectors, and electrical raceway work required in conjunction with panelboards and enclosures; not work of this Section.

1.3 QUALITY ASSURANCE

- A. Comply with the requirements of the NEC, as applicable to installation of panelboards, cabinets, and cutout boxes. Comply with the NEC requirements pertaining to installation of wiring and equipment in hazardous locations.
- B. Comply with applicable requirements of UL 67, "Electric Panelboards," and UL 50, UL 869, UL 486A, UL 486B, and UL 1053 pertaining to panelboards, accessories, and enclosures. Provide units which are UL-Listed and labeled.
- C. Comply with NEMA 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," and NEMA PB1, "Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less."

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Except as otherwise indicated, provide panelboards, enclosures, and ancillary components of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; design and construction in accordance with published product information; equip with proper number of unit panelboard devices as required for complete installation. Where

types, sizes, or ratings are not indicated, comply with the NEC, UL, and established industry standards for those applications indicated. Series rating is not acceptable for circuit breakers serving life safety equipment.

- B. Provide dead-front, safety-type, power distribution panelboards as indicated, with panelboard switching and protective devices in quantities, ratings, types, and arrangement shown; with mechanical type conductor connectors for Main, Neutral, and Ground lugs approve for copper or aluminum conductors. Specific circuit breaker placement is required in panelboards to match the circuit breaker placement indicated in the panelboard schedule on the drawings. Equip with aluminum busbars with not less than 98% conductivity and with neutral bus. Provide all 208Y/120 volt panelboards served by K4 rated transformers with 200% neutral bus. Provide suitable lugs on neutral bus for outgoing circuits requiring neutral connections. Provide bolt-on molded-case main and branch circuit breaker types for each circuit, with toggle handles that indicate when tripped. Where multiple-pole circuit breakers are indicated, provide with common trip so an overload on one pole will trip all poles simultaneously. Provide panelboards with bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate properly with panelboards. Branch mounted main circuit breakers are not acceptable. Provide bottom mounted main circuit breakers for panelboards fed from below. Provide top mounted main circuit breakers for panelboards fed from above. All spaces shall have bus fully extended and drilled for the future installation of breakers.
- C. Provide galvanized sheet-steel cabinet-type enclosures, in sizes and NEMA types as indicated, code gauge, minimum 16-gauge thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps, and doors with flush locks and keys. All panelboard enclosures shall be keyed alike. Equip with interior circuit directory frame and card with clear plastic covering. Provide baked gray enamel finish over a rust-inhibitor coating. Design enclosures for flush mounting unless otherwise indicated. Provide enclosures which mate properly with panelboards to be enclosed.
- D. Provide panelboard accessories and devices, including but not necessarily limited to circuit breakers and ground-fault protection units, as recommended by panelboard manufacturer for ratings and applications indicated. Provide electronic trip circuit breakers with adjustable trip settings for all life-safety emergency power feeders. Circuit breakers serving permanently connected appliances rated over 300 volt-amperes shall be provided with permanent lock-out devices. Circuit breakers serving surge protective devices "SPD" shall be located close to the equipment main circuit breaker or main lugs whether indicated or not. Provide HACR rated circuit breakers for all heating and air conditioning equipment. Provide GFCI circuit breakers where indicated. GFCI circuit breakers shall be Class A ground-fault protection (5-mA trip). Circuit breakers serving heat trace and ice melting equipment shall be provided with a permanent lockout device. Circuit breaker serving fire alarm panel shall be provided with Red color handle and Red color lock-out device with Fire Alarm label. Circuit breakers serving Elevator Emergency Communication Panel (ECS) shall be provided with Red color handle and Red color lockout device with ECS label. Circuit breakers serving Electric Hand Dryers shall be provided with a permanent lockout device. Circuit breakers serving Electric Water Coolers shall be GFCI type. Circuit breakers serving Vending Machines shall be GFCI type. Circuit breakers serving Water Heaters shall be provided with a permanent lock-out devices.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which panelboards and enclosures are to be installed, and notify the General Contractor, in writing, of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Install panelboards and enclosures as indicated, in accordance with manufacturer's published instructions, applicable requirements of the NEC and NECA "Standard of Installation," and in compliance with recognized industry practices to ensure that products fulfill requirements.
- C. Coordinate installation of panelboards and enclosures with raceway installation work.
- D. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.
- E. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.
- F. Provide properly wired electrical connections within enclosures.
- G. Provide a typed circuit index card for each panelboard upon completion of installation work. Indicate load served and room number(s). Use final room numbers obtained from the Architect or Owner, not construction room numbers as shown on the drawings.

3.2 GROUNDING

- A. Provide equipment grounding connections for all panelboards. Tighten connections to comply with tightening torques specified in UL 486A and UL 486B to assure permanent and effective grounding.

3.3 FIELD QUALITY CONTROL

- A. Keep panelboards clean and free from foreign matter of any kind, before, during, and after installation.
- B. Prior to energization of circuitry, check all accessible connections to manufacturer's tightening torque specifications.
- C. Prior to energization of panelboards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.

- D. Prior to energization, check panelboards for electrical continuity of circuits and for short-circuits.
- E. Subsequent to wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.
- F. Infrared Scanning: After Substantial Completion, but not more than 60 days from Final Acceptance, perform an infrared scan of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.
 - 1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 2. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262416

SECTION 262420 - MOTORS AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SCOPE OF WORK

- A. Furnish and install disconnect switches as indicated on the drawings and specified herein.
- B. Provide all power wiring, disconnect switches and electrical connections to all equipment provided and requiring electrical connections. Starters and/or magnetic contactors; including Variable Frequency Drives ("VFD") for HVAC equipment that is not integral with the HVAC equipment; shall be furnished by Division 23 Contractor, installed where and as indicated on the electrical drawings by the Electrical Contractor and provided with power wiring by the Electrical Contractor unless otherwise indicated. Power wiring between magnetic contactors and the final connection point on the HVAC equipment shall be provided under Division 26. Division 23 Contractor shall provide the proper number and size of auxiliary contacts in the magnetic contactors required for the proper operation and control of the HVAC equipment.
- C. All control wiring and conduits between control instruments and the magnetic contactor or VFD serving a piece of mechanical equipment shall be provided by Division 23 Contractor and installed in accordance with the requirements of Division 26, unless otherwise indicated on the electrical drawings or in the electrical specifications.
- D. Review the mechanical drawings and specification sections for exhaust fans requiring control by wall switch, solid state speed controller, or line voltage thermostat and provide same where indicated on the electrical drawings.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

- A. Disconnect switches shall be rated for the voltage of the equipment being served with number of poles and current rating as indicated. Disconnect switches shall be non-fusible or fusible type as indicated on the drawings.

- B. Switches shall be NEMA standard Heavy-Duty type.
- C. Switches shall be horsepower rated when used for motor disconnect means.
- D. Provide fused disconnect switches complete with appropriately sized fuses for the circuits controlled.

2.2 MOTOR RATED SWITCHES

- A. Motor rated switches shall be rated for the voltage of the equipment being served with number of poles and current rating as indicated.
- B. Motor rated switches shall be UL listed, suitable as motor disconnect, and industrial grade.
- C. Motor-rated switches shall be horsepower rated when used for motor disconnect means.

PART 3 - EXECUTION

3.1 INSTALLATION OF DISCONNECT SWITCHES

- A. Examine area and conditions under which electrical connections for equipment are to be installed. Notify the General Contractor; in writing; of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- B. Coordinate locations of disconnect switches and magnetic starters furnished under Division 23 with the locations of mechanical equipment, piping, electrical equipment and any and all other building elements such that all NEC requirements, including working clearances, are met. Adjust locations from those shown on the drawings as required to comply with NEC working clearance requirements at no additional cost to the project.
- C. Secure disconnects switches to building elements or equipment housings where indicated on the drawings. Where building walls or equipment housings do not provide suitable mounting surfaces, provide a galvanized unistrut frame or rack satisfactory in size to securely support the disconnect switch, magnetic contactor and /or VFD. Where racks are required to be roof mounted, secure the rack to the roof in a method that does not compromise the roof membrane in any way. Submit the roof attachment method to the Architect/Owner for approval prior to construction or installation.

3.2 ELECTRICAL CONNECTIONS TO EQUIPMENT

- A. Provide electrical connections to equipment indicated in accordance with equipment manufacturer's published instructions and recognized industry practices. Comply with applicable requirements of UL, the NEC and the NECA "Standard of Installation," to ensure that products fulfill requirements.

- B. Coordinate with other work, including wires/cables, raceway and equipment installation as necessary to properly interface installation of electrical connections to equipment with other work.
- C. Connect electrical power supply conductors to equipment in accordance with equipment manufacturer's published instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
- D. The contractor shall coordinate the following electrical requirements for all mechanical equipment with the Division 23 Contractor:
 - 1. Number of electrical connections.
 - 2. Number and size of feeders' terminal lugs.
 - 3. Maximum overcurrent protection.
 - 4. Size and type of fuses.
- E. Cover splices with electrical insulating material equivalent to or greater than the electrical insulation rating of the conductors being spliced.
- F. Prepare cables and wires by cutting and stripping covering, armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Avoid "ringing" conductors while skinning wire.
- G. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.
- H. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torquing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL 486A.
- I. Provide flexible steel conduit for motor connections and other electrical equipment connections where subject to movement and vibration.
- J. Provide liquid-tight flexible steel conduit for connection of motors and other electrical equipment where subject to movement and vibration and where connections are located where subject to any of the following conditions:
 - 1. All exterior locations
 - 2. Moist or humid atmosphere where condensation can be expected to accumulate (Example: sump pump and elevator pits)
 - 3. Corrosive atmosphere (Example: battery charging rooms)
 - 4. Water spray
 - 5. Dripping oil, grease, or water
 - 6. Kitchens and Sculleries

3.3 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical connections and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

END OF SECTION 262420

SECTION 262726 - WIRING DEVICES AND DEVICE PLATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. **Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.**

1.2 SCOPE OF WORK

- A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of the electrical distribution systems which are intended to carry but not utilize electric energy.
- B. Types of electrical wiring devices in this Section include the following:
 - Receptacles
 - Ground-fault circuit interrupters
 - Switches
 - Cover plates
- C. Comply with the requirements of the NEC, as applicable to installation and wiring of electrical wiring devices.
- D. Comply with applicable requirements of UL 20, 486A, 498, 943, and 1472 pertaining to installation of wiring devices. Provide wiring devices which are UL-Listed and labeled.
- E. Comply with applicable portions of NEMA WD1, "General-purpose Wiring Devices, and WD5, "Wiring Devices, Specific Purposes."

PART 2 - PRODUCTS

2.1 FABRICATED WIRING DEVICES

- A. Provide factory-fabricated wiring devices in types and electrical ratings for applications indicated and which comply with NEMA WD1. Provide white colored-devices.

2.2 RECEPTACLES

- A. Duplex: Provide Industrial/Institutional, Specification-Grade, Tamper Resistant TR duplex receptacles, 2-pole, 3-wire, grounding, with green hexagonal equipment ground screw, single-piece brass mounting yoke with integral ground terminals, 20 amperes, 125 Volts, with metal plaster ears; designed for side and back wiring, with NEMA configuration 5-20R, unless otherwise indicated. LEVITON 5362, Tamper Resistant TR Series, or approved equal.
- B. Simplex: Provide Industrial/Institutional, Specification-Grade, Tamper Resistant TR, single receptacles, 2-pole, 3-wire, grounding, with green hexagonal equipment ground screw, 20 amperes, 125 Volts, with metal plaster ears; designed for side and back wiring, with NEMA configuration 5-20R, unless otherwise indicated. LEVITON 5361, Tamper Resistant TR Series, or approved equal.
- C. Ground-fault Circuit Interrupters: Provide Industrial/Institutional, Specification-Grade, Tamper Resistant TR, “feed-thru”-type ground-fault circuit interrupters, with heavy-duty duplex receptacles, capable of being installed in a 2-3/4" deep outlet box without adapter, grounding type UL-rated Class A, Group 1, rated 20 amperes, 120 Volts, 60 Hz; with solid-state ground-fault sensing and signaling; with 5 mA ground-fault trip level; equipped with NEMA configuration 5-20R. LEVITON model 7899, Tamper Resistant TR Series, or approved equal.
- D. Ground-fault Weather Resistant Circuit Interrupters; Provide Industrial/Institutional, Specification-Grade, Tamper Resistant TR, “feed-thru”-type ground-fault circuit interrupters, with heavy-duty duplex receptacles, capable of being installed in a 2-3/4" deep outlet box without adapter, grounding type UL-rated Class A, Group 1, rated 20 amperes, 125 Volts, 60 Hz; with solid-state ground-fault sensing and signaling; with 5 mA ground-fault trip level; equipped with NEMA configuration 5-20R. LEVITON model WR899-W, Tamper Resistant TR or approved equal.
- E. Combination Duplex receptacle with two Type A USB Chargers, Tamper Resistant; Provide Combination Duplex Receptacle/Outlet and USB Charger, 20 Amp, 125 Volt, Decora Tamper-Resistant Receptacle/Outlet, Self-Grounding, NEMA 5-20R with two Type A USB Chargers, LEVITON model T5832 or approved equal. When class 2 power is required, receptacle shall be listed and constructed such that the class 2 circuitry is with the receptacle.
- F. Combination Duplex receptacle with one Type A and one Type C USB Chargers, Tamper Resistant; Provide Combination Duplex Receptacle/Outlet and USB Charger, 20 Amp, 125 Volt, Decora Tamper-Resistant Receptacle/Outlet, Self-Grounding, NEMA 5-20R with one Type A and one Type C USB Chargers, LEVITON model T5833 or approved equal.

2.3 SWITCHES

- A. Snap: Provide Specification-Grade, flush, single-pole toggle switches, 20 amperes, 120/277 Volts AC, with mounting yoke insulated from mechanism, equipped with plaster ears, switch handle, equipment grounding screw, and side-wired screw terminals. LEVITON 1221-2 Series or approved equal. Provide for key operation where indicated on drawings.

- B. Three Way: Provide Specification-Grade, flush, 3-way switches, 20 amperes, 120/277 Volts AC, with mounting yoke insulated from mechanism, equipped with plaster ears, switch handle, equipment grounding screw, side-wired screw terminals, with break-off tab features, which allow wiring with separate or common feed. LEVITON 1223-2 Series or approved equal. Provide for key operation where indicated on drawings.
- C. Four Way: Provide Specification-Grade, flush, 4-way quiet switches, 20 amperes, 120/277 Volts AC, with mounting yoke insulated from mechanism, equipped with plaster ears, switch handle, equipment grounding screw, side-wired screw terminals, with break-off tab features, which allow wiring with separate or common feed. LEVITON 1224-2 Series or approved equal. Provide for key operation where indicated on drawings.

2.4 WIRING DEVICE ACCESSORIES

- A. Cover plates: Provide mid-size (JR Jumbo) stainless steel cover plates for single and combination wiring devices of types and with ganging and cutouts as required. Provide metal screws for securing plates to devices; screw heads colored to match color of plates. Provide stainless-steel cover plates in mechanical and electrical equipment rooms. Provide all receptacles connected to emergency circuits with red color coverplates. Red color coverplates shall be type 302, labeled with 1.8" high engraved, and filled lettering "Emergency".
- B. Provide "metal extra duty weatherproof-while-in-use" rated cover plates for receptacles installed outdoors where exposed to weather.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES

- A. Install wiring devices where indicated in Contract Documents in accordance with manufacturer's published instructions, applicable requirements of the NEC and NECA "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other work, including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices with other work.
- C. Install wiring devices only in electrical boxes which are clean, free from building materials, dirt, and debris.
- D. Install wiring devices after wiring work is completed.
- E. Install cover plates after painting work is completed. Label the inside face of each cover plate with indelible black marker indicating the number of each circuit contained in or running through the outlet box.

- F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B. Use properly scaled torque indicating hand tool.
- G. Terminate all switch and receptacle wiring on side screw terminals. Back terminations are not permitted.
- H. Install all switches and receptacles with sufficient wiring length such that the device may be extracted from the outlet box a minimum of 6" while still connected.
- I. Install grounded conductors at the location of switches per the requirements of NEC Article 404.
- J. Switches that are combined in the same enclosure that exceed 300 volts are prohibited.
- K. Receptacle that are used during construction after permanent power is energized shall be replaced at the final completion of the project.

3.2 PROTECTION OF COVER PLATES AND RECEPTACLES

- A. Upon installation of cover plates and receptacles, take caution regarding use of convenience outlets. At time of Substantial Completion, replace all cover plates and receptacles which have been damaged; during the execution of this project; including those painted over, burned, or scored by faulty plugs.

3.3 GROUNDING

- A. Provide equipment grounding connections for wiring devices, unless otherwise indicated. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounding.

3.4 TESTING

- A. Prior to energizing circuitry, test wiring for electrical continuity and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energization, test wiring devices to demonstrate compliance with requirements. The proper outlet testing equipment shall be used to test receptacles.

END OF SECTION 262726

SECTION 264313 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SCOPE

- A. The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 RELATED SECTIONS

- A. Section 262416 – Panelboards

1.3 REFERENCES

- A. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 latest addition).

1.4 SUBMITTALS – FOR REVIEW/APPROVAL

- A. The following information shall be submitted to the Engineer:
 - 1. Provide verification that the SPD complies with the required ANSI/UL 1449 Latest Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (I_n).
 - 2. Electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.
- B. Where applicable the following additional information shall be submitted to the engineer:
 - 1. Descriptive bulletins
 - 2. Product sheets

1.5 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- D. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.

1.7 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall be provided with each SPD shipped.

PART 2 - PRODUCTS

2.1 VOLTAGE SURGE SUPPRESSION – GENERAL

- A. Electrical Requirements:
 - 1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
 - 2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.
 - 3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
 - 4. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

| Configuration | Protection Modes | | | |
|--------------------|------------------|-----|-----|-----|
| | L-N | L-G | L-L | N-G |
| Wye | ● | ● | ● | ● |
| Delta | N/A | ● | ● | N/A |
| Single Split Phase | ● | ● | ● | ● |
| High Leg Delta | ● | ● | ● | ● |

5. Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.
6. ANSI/UL 1449 Latest Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 Latest Edition VPR for the device shall not exceed the following:

| Modes | 208Y/120 | 480Y/277 |
|-------|----------|----------|
| L-L | 1200 | 2000 |
| L-N | 800 | 1200 |
| L-G | 800 | 1200 |
| N-G | 700 | 1200 |

B. SPD Design:

1. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
2. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.
3. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.
4. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
5. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:
 - a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
 - 1) For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection

- elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
- 2) For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
 - 3) The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.
- b. Remote Status Monitor – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
 - c. Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.
 - d. Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of $50 \pm 20A$ occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.
 - 1) The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.
6. Overcurrent Protection:
- The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.
7. Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

8. Safety Requirements:

The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

- a. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.
- b. SPDs shall be factory sealed in order to prevent access to the inside of the unit. SPDs shall have factory installed phase, neutral, ground and remote status contact conductors factory installed and shall have a pigtail of conductors protruding outside of the enclosure for field installation.

2.2 SYSTEM APPLICATION

- A. The SPD applications covered under this section include distribution and branch panel locations and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.
- B. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

| Minimum Surge Current Capacity Based on ANSI / IEEE C62.41 Location Category | | | |
|--|--------------------------------|-----------|----------|
| Category | Application | Per Phase | Per Mode |
| A | Branch Locations (Panelboards) | 120 kA | 60 kA |

- C. SPD Type – SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.
- D. Branch panelboards SPD's shall be connected to 30 amp, 3 pole circuit breakers.

2.3 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

- A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
 1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
 2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.

3. The panelboard shall be capable of re-energizing upon removal of the SPD.
4. The SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.

B. Side mount Mounting Applications Installation (SPD mounted external to electrical assembly):

1. Lead length between the breaker and suppressor shall be kept as short as possible to ensure optimum performance. Any excess conductor length shall be trimmed in order to minimize let-through voltage. The installer shall comply with the manufacturer's recommended installation and wiring practices.

2.4 ENCLOSURES

A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:

1. NEMA 1 – Constructed of steel intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects.

PART 3 - EXECUTION

3.1 FACTORY TESTING

- A. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.**

3.2 INSTALLATION

- A. The Contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.**

3.3 WARRANTY

- A. The manufacturer shall provide a full ten (10) year warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local code.**

END OF SECTION 264313

SECTION 265100 - INTERIOR BUILDING LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 DEFINITIONS

| | |
|--------|---|
| CRI: | Color-rendering index. |
| CU: | Coefficient of utilization. |
| RCR: | Room cavity ratio. |
| L70: | Minimum 70% maintained initial-rated lumens at average rated life for LEDs. |
| IESNA: | Illuminating Engineering Society of North America |
| LM-80: | IESNA approved method of measuring Lumen Depreciation of LED Light Sources |
| LED: | Light Emitting Diode |
| UL: | Underwriter Laboratories |

1.3 SCOPE OF WORK

- A. Extent of interior light fixture work is indicated by drawings and schedules.
- B. Light fixtures shown installed on exterior walls or under canopies attached to the building are considered interior building lighting.
- C. Types of interior light fixtures in this Section include the following:
 - Light-emitting Diode

1.4 QUALITY ASSURANCE

- A. Comply with the requirements of the NEC, as applicable to installation and construction of interior building light fixtures.
- B. Provide interior light fixtures which are UL-Listed and labeled.

- C. Provide LED drivers which comply with NEMA SSL-1, "Electronic Drivers for LED Devices, Arrays, or Systems", and SSL-3, "High Power White LED Binning for General Illumination".

PART 2 - PRODUCTS

2.1 INTERIOR LIGHT FIXTURES

- A. Provide light fixtures of sizes, types, and ratings indicated; complete with, but not limited to, housings, reflectors, LED module, LED drivers and wiring. Provide fixture trims as required for proper installation into the type ceiling in which installed. Review Architectural reflected ceiling plans for ceiling types and construction and provide all mounting hardware required for proper installation of the fixtures specified for the location.
- B. Air-Handling Fixtures: Fixtures used as air-handling registers shall meet requirements of NFPA.

2.2 LED LIGHT FIXTURES

- A. LED fixtures shall be in compliance with UL.
- B. Interior Area LED Fixtures:
 - 1. Kelvin temperature of interior fixtures as indicated on drawings.
 - 2. Minimum of 75 plus lumens per watt.
 - 3. CRI 80 or greater.
 - 4. 5-year warranty minimum with L70 of 50,000 hours or greater.
 - 5. Modular design for field replacement of parts.
 - 6. Tool less access to driver and LED modules.
 - 7. Cannot have LED pixilation (or commonly called bug eye effect).
 - 8. UL certified up to 90F degrees operating temperature.
- C. Manufactured by one of the following:
 - 1. Nichia Corporation.
 - 2. Cree, Inc.
 - 3. Philips LumiLED.
 - 4. Osram Opto Semiconductors.
 - 5. Cooper Industries.
 - 6. Lusio Lighting.
 - 7. Sony.
 - 8. Citizens Electronics

2.3 RECESS- AND FLUSH-MOUNTED FIXTURES

- A. Provide light fixture types which can be relamped from the bottom. Access to driver shall be from the bottom. Trim for the exposed surface of flush-mounted fixtures shall be as required for the ceiling construction in which it is installed.

2.4 SUSPENDED FIXTURES

- A. Provide hangers capable of supporting twice the weight of the fixture supported by the hanger. Hangers shall allow fixtures to swing within an angle of 20 degrees. Multiple-unit or continuous row fixtures shall have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end, unless indicated otherwise. Rods shall be a minimum 1/4" diameter.

2.5 EXIT LIGHTS

- A. Exit lights shall be in conformance with UL and NFPA. Exit lights shall be self-powered type where indicated.
- B. Self-Powered LED-Type Exit lights (Battery Backup): Provide with automatic power failure device, test switch, pilot light and fully automatic high/low trickle charger in a self-contained power pack. Battery shall be sealed electrolyte type, shall operate unattended, and require no maintenance, including no additional water, for a period of not less than 5 years. LED exit lights shall have emergency run time of 1.5 hours (90 minutes) minimum.

2.6 EMERGENCY LIGHTING EQUIPMENT

- A. Equipment shall be in conformance with UL and NFPA. Provide lamps in wattage indicated.
- B. Emergency Lighting Unit: Provide as indicated. Emergency lighting units shall be rated for 12 volts, except units having no remote-mounted lamps and having no more than two unit-mounted lamps may be rated 6 volts.
- C. LED Emergency Driver: Each unit shall consist of an automatic power failure device, test switch operable from outside of the fixture, pilot light visible from outside the fixture, and fully automatic solid-state charger in a self-contained power pack. Charger shall be either trickle, float, constant-current or constant-potential type, or a combination of these. Battery shall be sealed electrolyte type with capacity as required to supply power to two LED circuit boards for 90 minutes at a minimum of 800 lumens output power. Battery shall operate unattended and require no maintenance for a period of not less than 5 years.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install interior light fixtures at locations and heights as indicated in accordance with fixture manufacturer's published instructions, applicable requirements of the NEC, NECA "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that light fixtures fulfill requirements.
- B. Coordinate with all other work on this Contract as appropriate to properly interface installation of interior light fixtures.
- C. Fasten fixtures securely to building structural members, and check to ensure that solid pendant fixtures are plumb. Recessed fixtures shall be supported with individual annealed, light zinc-coated finish, 12-gauge wire from all four corners tied to building structural members. Securing safety wires to bridging is not acceptable. The supporting wires shall be distinguishable by color or tagging.
- D. Clean interior light fixtures of dirt and debris (including lenses) upon completion of installation.
- E. Protect installed fixtures from damage during entire construction period.

3.2 FIELD QUALITY CONTROL

- A. Upon completion of installation of interior light fixtures and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- B. At the time of Substantial Completion, replace lamps in interior light fixtures which are observed to be noticeably dimmed after Contractor's use and testing, as judged by the Architect.

3.3 GROUNDING

- A. Provide tight equipment grounding connections for each interior light fixture installation.

END OF SECTION 265100

SECTION 271500 - DATA/COMMUNICATION SYSTEMS CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 DESCRIPTION OF WORK

- A. It is the purpose of this Specification to require the furnishing of the highest quality materials, equipment, and workmanship available, to fulfill the requirements of the work specified herein.
- B. The Data/Communication Systems Cabling shall provide enhanced Category 5 UTP Data Cabling Infrastructure and a Fiber Backbone to a network operating system and application software to be provided by the Owner.
- C. Work Included:
 - 1. Provide all labor, equipment, supplies, materials, and incidentals and all operations necessary for the "TURNKEY," fully tested, and completed installation of a Data/Communications Systems Cabling, in complete accordance with the Contract Documents.
 - 2. The work shall include, but not be limited to, the following:
 - a. Coordination of the Raceway installation.
 - b. Furnish Special Backboxes, as indicated on the drawings, for installation under Division 26.
 - c. Furnish and Install all Cabinets and Enclosures.
 - d. Furnish, Install, and certify the Data/Communication Cable System.

1.3 PERMITS AND INSPECTIONS

- A. Obtain and pay for all permits and inspections required by all legal authorities and agencies having jurisdiction for the work. These permits or inspections shall be a part of the work of the Contractor performing the work.

1.4 SUBMITTALS

- A. Submit the following Shop Drawings and Submittals, per the schedule listed below for review by the Architect:

1. Prior to proceeding with the work:

- a. A complete schedule of ALL equipment and materials shall be furnished for the work. Accompanying the schedule shall be manufacturer's specification or data sheets for all major components listed in PART 2 of this Specification.
- b. Shop Drawings: Complete shop drawings for all systems and assemblies specified. Each drawing shall have a descriptive title and all subparts of each drawing shall be labeled. All drawings shall have the name and location of the project and the installing contractor's name in the title block. Data/Communication System Cabling shop drawings shall not be combined with any other auxiliary system shop drawings.
- c. Cabinets & Assemblies: Complete CAD-generated scaled drawings of all equipment racks and assemblies. Each drawing shall show all equipment with its manufacturer and model number.
- d. Device Locations: Complete CAD-generated scaled building drawings detailing installation locations of all data ports, data closets, equipment racks, etc. All conduit with cable quantities and types shall also be indicated.
- e. Device Layout: Complete CAD-generated scaled drawings detailing all data plates, patch panels, input/output panels, rack panels and custom components to be fabricated by the Contractor. Include the same details for all custom or non-standard components to be furnished by vendor/manufacturers of the Contractor. Show all connectors, mounting devices and engraving, and other labeling detail on these drawings.
- f. Contractor job references and key employee résumés, as described in the Contractor Qualifications portion of this Specification.
- g. Qualification Statements of any proposed subcontractors to meet the requirements in the Contractor Qualifications portion of this Specification.
- h. Contractor certificates as described in Paragraph 2.1 and in the Data Infrastructure Section of this Specification.

2. Prior to proceeding with respective portions of work:

- a. Artwork, drawings, and listings indicating proposed nameplate nomenclature and arrangements for patch panels, plug panels, and nameplates prior to fabrication.
- b. Front panel layouts for all equipment racks, prior to installation, reflecting equipment to be used.
- c. Details and descriptions of any other aspect of the system which differ from the contract drawings due to field conditions or due to the equipment furnished.
- d. Submittal as otherwise noted on the drawings and/or as noted herein.
- e. Approved shop drawings and instruction brochures, including schematic diagrams for all electronic devices, shall be present at the job site during the period set aside for system testing.

3. At Project Completion:

- a. Notebooks of operating instructions shall be prepared for the Owner as described herein.
- b. Record drawings: Prior to Final Acceptance, provide three complete sets of drawings showing all cable numbers and construction details in accordance with the actual system installation. Revise all shop drawings to represent actual installation conditions.
- c. Operation and Maintenance Manuals: Prior to Final Acceptance, provide three complete sets of operation and maintenance manuals for the system. The operation manual shall contain all instruction necessary for the proper operation of the installed system and manufacturers' instruction. The maintenance manual shall contain all "proof of performance" information as required in PART 3, and all manufacturers' maintenance information, and copies of non-priority computer programs and system set-up disks documenting all programmable features for the installed system.

1.5 DEFINITION OF TERMS

- A. The term "Contractor" shall refer to the person, persons, or company who or which actually contracts to perform the Data Communications System work specified herein.
- B. The term "data/telephone/fax/modem port" shall refer to the location where all three CAT 5E cables are connected. All data and/or data/telephone/fax/modem ports are to be fully activated with complete network accessibility without the need to alter any cable configurations anywhere on the network.

1.6 CONTRACTOR QUALIFICATIONS

- A. The Contractor must be a contractor who has been regularly engaged in the furnishing and installation of data communications and related voice, data and video communications systems for a period of at least the last three (3) years and who can show evidence of successfully completing, with its present staff, at least three (3) projects of similar size and scope. The Contractor, not its employees, must meet these Contractor qualifications. With the submittal, provide a list of jobs completed, with contact, address and phone number of the Owner, and the Contractor's key employees assigned to the project, listing their responsibilities during the job and the length of time with the Contractor in this capacity.
- B. The Contractor shall demonstrate to the satisfaction of the Architect/Engineer and Owner that they have:
 1. Adequate plant and equipment to pursue the work properly and expeditiously.
 2. Adequate staff and technical experience to implement the work.
 3. Technically capable and factory trained service personnel at a Contractor-owned service facility within fifty (50) miles radius of the project site, to provide routine and emergency service for all products used in the project.
- C. The Contractor shall:

1. Be bondable.
 2. Hold a Class A Contractor's License which is accepted as valid within the State of Virginia.
- D. Any contractor, who intends to bid on this work and does not meet the requirements of the "Contractor Qualifications" paragraph(s) above, shall employ the services of a Contractor who does meet the requirements and who shall furnish the equipment, shop fabricate the equipment racks and subassemblies, make all connections to equipment and equipment racks, make all connections to all connection panels and plates, test the completed system, and continuously supervise the installation and connections of all system cable and equipment.
- E. A subcontractor so employed shall be acceptable to the Architect/Engineer and Owner and shall be identified in the submittal.

1.7 QUALITY ASSURANCE

- A. General: All equipment and materials required for installation under these Specifications shall be new (less than 1 year from date of manufacture) and without blemish or defect.
- B. Specific: Each major component of equipment shall have the manufacturer's name, address, and model number on a plate securely affixed in a conspicuous place. NEMA code ratings, UL label, or other data which is die-stamped into the surface of the equipment shall be easily visible.
- C. Substitutions:
1. Where a specific piece of equipment has been discontinued and/or replaced by a new model, submission of the new model does not guarantee acceptance. Substitute items shall require evaluation by the Architect/Engineer, Owner or their agent prior to acceptance.
 2. If substitute equipment is allowed even by an approved submittal, the Contractor shall be completely responsible for its use and for its ability to fulfill all intended functions in the completed systems. The Contractor shall replace all such equipment with equipment listed by type and model number in the Specifications if there is any evidence of equipment instability and/or incompatibility.
 3. Any use of substitute equipment shall be at no extra cost to the Owner.

PART 2 - PRODUCTS

2.1 SINGLE SOURCE RESPONSIBILITY

- A. Except where specifically noted otherwise, all equipment supplied for the Data and/or Data/Communication Systems shall be the standard product of a single manufacturer of known reputation and experience in the industry. The Contractor shall have attended the manufacturer's installation and service schools. Certificates of this training shall be provided with the Contractor's submittal.

2.2 DATA CABLE INFRASTRUCTURE

A. Twisted Pair Cable:

1. Cabling shall be unshielded twisted pair (UTP) and shall meet EIA/TIA-568, requirements for Category 5E. The following specifications shall apply:
 - a. Conductors: #24 AWG solid copper, 4 pair;
 - b. Impedance: 100 ohms $\pm 15\%$ at 1-350 MHz;
 - c. Mutual Capacitance: 14 pf/ft. nominal at 1 MHz;
 - d. Attenuation (per 1000 ft):
 - 1) 6.3 dB at 1 MHz
 - 2) 13.0 dB at 4 MHz
 - 3) 20.0 dB at 10 MHz
 - 4) 25.0 dB at 16 MHz
 - 5) 28.0 dB at 20 MHz
 - 6) 52.0 dB at 62.5 MHz
 - 7) 67.0 dB at 100 MHz
 - 8) 155.0 dB at 155 MHz
 - 9) 99.0 dB at 200 MHz
 - 10) 300.00 db at 125 MHz
 - 11) 137 db at 350 MHz
2. Provide one "homerun" UTP cable between each data port indicated on the drawings and the appropriate data/communications patch panels cabinets.
3. In-field splicing of UTP cables shall not be permitted.
4. UTP cables shall not exceed 90 meters from the data outlet port to the appropriate IDF/MDF patch panel.
5. The National Electrical Code, Article 800, Type CMP specification shall be considered when UTP cables are installed, without benefit of adequate raceway, in a plenum air return.
6. CMR-rated UTP cables shall be WEST PENN WP56470, or equivalent.

B. Fiber Optic Cable:

1. Fiber Optic cabling shall meet the following specifications:
 - a. Glass type shall be 62.5 micron core;
 - b. Glass cladding shall be 125 micron;
 - c. Glass type shall be multi-mode;
 - d. Each fiber shall have a color coded 900 micron tight buffer;
 - e. Each cable shall contain an up-jacketed central strength member;
 - f. Maximum attenuation at 850/1300 nm shall be 3.5/1.25 dB/Km;
 - g. Minimum bandwidth at 850/1300 nm shall be 160/500 MHz-km;
 - h. Each cable shall have a minimum short-term bend radius of 10X the cable diameter;

- i. Each cable shall have a minimum long-term bend radius of 15X the cable diameter.
 2. In-field splicing of fiber optic cables shall not be permitted.
 3. The National Electric Code, Type OFNP Specification shall be considered when fiber optic cables are installed, without benefit of adequate raceway, in a plenum air return.
 4. OFNR-rated fiber optic cables shall be WEST PENN WP92039, or equivalent.
- C. Fiber Optic Connectors:
 1. Fiber Optic connectors shall meet the following specifications:
 - a. Connectors shall be pigtail **[ST] [LC]** types that are fusion spliced.
- D. Fiber Optic Termination Box: Fiber optics cable termination box shall be 24 port SMP P/N WTC-24A (LIU) with ST-type connectors.
- E. Data Station Outlets:
 1. Face Plates: Data Station Outlets shall be provided as indicated on the drawings and meet the following specifications:
 - a. Single gang, mid-size (JR Jumbo), stainless steel cover plates for single and combination wiring devices of types and with ganging and cutouts as required. Provide metal screws for securing plates to devices; screw heads colored to match color of plates.
 - b. Shall accept data, telephone, fax, modem and blank insert modules;
 - c. Shall have the capability to accept up to three individual ports;
 - d. Inserts shall snap in and out from the front of the Data/Communication Station Outlet;
 - e. Face plates shall be supplied with pressure-sensitive icon labels;
 2. Inserts:
 - a. Data/Communications Port inserts shall be as follows: SMP P/N UMJEFS-XX with Red color Bezzel P/N BE-08-03D. Data jack must be located on the top of the face plate.
 - b. Telephone Inserts shall be as follows: SMP P/N UMJEFS-XX with Green color Bezzel P/N BE-08-04V. Telephone jack must be located in the center of the face plate.
 - c. Fax/Modem Inserts shall be as follows: SMP P/N UMJEFS-XX with Blue color Bezzel P/N BE-08-05F. Fax/Modem jack must be located on the bottom of the face plate.
 - d. Blank inserts shall be Mod-Tap 17-0433-01, or equivalent.
- F. Patch Panels:
 1. Patch panels shall be provided at each Data wall cabinet and telephone wall cabinet. Provide a minimum of 10 future data, telephone and fax/modem connections in each data and telephone cabinets. Provide number of patch panels as required to terminated

all cables indicated on the contract document plus 10 future connections in each cabinet. Patch panels shall meet the following specifications:

- a. 24 port 568B patch panel, SMP DCC2488/EFS01.
 - b. 32 port 568B patch panel, SMP DCC3288/EFS01.
 - c. 64 port 568B patch panel, SMP DCC6488/EFS01.
 - d. 48 port 568B patch panel, SMP DCC4888/EFS01.
 - e. 64 port 568B patch panel, SMP DCC6488/EFS01.
2. Provide a three (3) foot minimum patch cable for every Category 5E UTP data cable terminated to a patch panel. Install and neatly route patch cables between the panel and the concentrators utilizing cable management hardware.
- G. Data and Telephone Racks: Provide 36" x 19" wall-mounted, swing-out rack, HUBBELL MCC-36WMR19, with swing gate bracket kit for above rack HUBBELL MCCSGBK, or equal.
- H. Telephone Cable Termination Box: 200 pair direct burial, 22 GA, Copper-type telephone cable shall be terminated on Circa 1880-ENA-110-200 gas-protected cable termination boxes. One box will be located in the basement of **Newport News City Hall Building. The second box will be located in the new Juvenile Detention Center, Room C125.** The two termination boxes shall be grounded in accordance with manufacturer's requirements for lightning and surge protection. All used and unused pair positions shall have gas protection units in place.
- I. Certification:
1. Contractor shall be factory certified to install the Data Cabling Infrastructure. The Contractor shall include a copy of the factory-provided certification with his submittal.
 2. The manufacturer of the passive, data connectivity components shall warrant the passive components of the Data Cabling Infrastructure for a period of fifteen (15) years, if installed by its factory certified contractor.

PART 3 - EXECUTION

3.1 GENERAL

- A. Perform the work in accordance with acknowledged industry and professional standards and practices, and the procedures specified herein.
- B. Furnish and install all materials, devices, components, and equipment for complete operational systems.
- C. Maintain a competent supervisor and supporting technical personnel, acceptable to the Architect/Engineer during the entire installation. Change of the supervisor during the project shall not be acceptable without prior written approval from the Architect/Engineer.

- D. Coordinate all efforts with those of related trades. In the event of any conflicts, delayed or improper preparatory work by others, notify the Architect/Engineer. The Architect's/Engineer's decision shall be binding. Verify all field conditions.

3.2 INSTALLATION OF SYSTEMS

- A. Device Locations: Locate all apparatus requiring adjustments, cleaning, or similar attention so that it shall be accessible for such attention. Equipment racks shall be positioned to permit full access for operation and service.
- B. Blank and Custom Panels: Finish of blank panels and custom assembly panels shall match adjacent equipment panels as closely as possible.
- C. Markings: Ports, cables, and cable terminations shall be logically and permanently marked. Hand-written tags will not be accepted.
- D. Environment: The equipment specified herein is designed to operate in environments of normal humidity, dust, and temperature. Protect equipment and related wiring during installation where extreme environmental conditions can occur.
- E. Conduit: The Contractor shall be responsible for reviewing and coordinating conduit installation for the system with the Division 26 Prime Contractor. All wiring shall be in conduit as indicated on the drawings unless specifically authorized by the Engineer and permitted by Code.

3.3 ELECTRICAL POWER

- A. Grounding: Review and coordinate electrical power system installation, including grounding, to ensure proper operation of the system.
- B. Verification: Verify that all AC power circuits designated for the system are properly wired, phased, and grounded.
- C. Equipment Rack: Provide distribution of electrical power within the equipment racks with a minimum of two spare AC receptacles per branch circuit, used in the racks.

3.4 CLEANING

- A. Clean all junction and terminal box interiors thoroughly before installing plates, panels, or covers.

3.5 WIRING METHODS AND PRACTICES

- A. Identification: All wires shall be permanently identified at each wire by marking with "E-Z" tape marker or equivalent.

- B. Terminal Blocks: All terminal block connections shall be readily accessible. Not more than two wires connected to one terminal. Spare terminal blocks, equivalent to 10% of those in actual use, shall be provided.
- C. Splicing: Splicing of cables shall not be permitted between terminations at specified equipment.
- D. Pulling Cable: Do not pull wire or cable through any box fitting or enclosure where change of raceway alignment or direction occurs. Do not bend conductors to less than recommended radius. Employ temporary guides, sheaves, rollers, and other necessary items to protect cables from excess tension, abrasion, or damaging bending during installation.
- E. Cable Tie: Form in a neat and orderly manner all conductors in enclosures and boxes, wireways, and wiring troughs, providing circuit and conductor identification. Tie as required using T & B "Ty-Raps" (or equivalent) of appropriate size and type. Limit spacing between ties to 6" and provide circuit and conductor identification at least once in each enclosure.
- F. Service Loops: Provide ample service loops at each termination so that plates, panels, and equipment can be demounted for service and inspection.
- G. Wiring Harnesses:
 - 1. All wires and cables entering equipment racks shall be formed into harnesses which are tied and supported in accordance with accepted Engineering practice.
 - 2. Harnessed cables shall be formed in either a vertical or horizontal relationship to equipment, components, or terminations.

3.6 EQUIPMENT RACKS

- A. General: The equipment racks shall be considered as custom assemblies and shall be assembled, wired, and tested in a properly equipped shop maintained by the Contractor. Assembly of racks on site shall not be permitted.
- B. Equipment Location: Placement of equipment in equipment racks, as indicated in the drawings, is for maximum operator convenience. Verify any changes in placement prior to assembly. All system components and related wiring shall be located with due regard for the minimization of induced electromagnetic and electrostatic noise, for the minimization of wiring length, for proper ventilation, and to provide reasonable safety and convenience for the operator.
- C. Rack Installation: Racks shall be installed plumb and square without twists in the frames or variations in level between adjacent racks.
- D. Identification: All terminal blocks and rack-mounted equipment shall be clearly and logically labeled as to their function, circuit, or system as appropriate. Labeling on manufactured equipment shall be engraved plastic laminate with white lettering on black or dark background that is similar to panel finish.

3.7 ACCEPTANCE TESTING

- A. The Acceptance Testing shall be performed by the Owner or the Owner's agent. Coordinate this period so that free access, work lighting, and electrical power is available on the site.
- B. Be prepared to verify the performance of any portion of the DCS system by demonstration and instrumented measurements.

3.8 SYSTEM DOCUMENTATION

- A. Prior to Final Acceptance Tests, submit to the Architect three (3) copies of an operating and maintenance manual for the system that has been installed. These manuals shall be used during the Final Acceptance Testing of the system. Each manual shall contain the following information:
 - 1. Record drawings
 - 2. Operations and maintenance manuals
 - 3. Single line diagrams showing levels throughout system and impedances
 - 4. Provide test certification for CAT-5E at 350 Mbps and Fiber cable at 850nm. Provide one hard copy and one disk compatible with Microsoft Office Excel for these test results to the City's Project Manager.

3.9 WARRANTY

- A. The Contractor shall guarantee all components and labor of the work defined in this Specification for a period of one year after Final Acceptance by the Owner. The following conditions shall apply:
 - 1. The Contractor shall provide service within eight (8) hours, after notification by the Owner or his representative, within the hours of 8:00 a.m. to 5:00 p.m. from Monday through Friday. Service Request forms shall be supplied to the Owner and the faxing or mailing of such a request form shall constitute notification by the Owner of a service request.

END OF SECTION 271500

SECTION 275125 - IN-BUILDING BI-DIRECTIONAL AMPLIFIER SYSTEM (BDA)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 DESCRIPTION OF WORK

- A. It is the intent this specification to provide an in-building bi-directional amplifier (BDA) system to ensure proper operation of the City's trunked radio system within the existing and the new addition.
- B. The purpose of this system is to provide communication coverage for public safety personnel when performing their duties in the building. The intent of this system is to provide the necessary coverage, so that these personnel will be able to communicate anywhere within the building, to exterior commanders, personnel, and dispatchers under the worst of conditions.

C. Scope:

1. Distributed Antenna System:

The contractor shall design and provide a distributed antenna system, capable of delivering a minimum -95 dBm signal to the antenna of a belt-worn portable radio. This system may use any technology desired by the contractor and approved by the City. It will be the responsibility of the contractor to provide proof of adequate coverage.

- 2. The contractor shall also consider building construction in the design of this system, and ensure maximum system gain and coverage, while providing maximum transmits to receive isolation, guarding against system feedback and self-oscillation.

3. Coordination:

The BDA system contractor shall coordinate his design and propose locations for placement of hardware, cable-runs and wall penetrations. Locations shall be approved by the City of Suffolk prior to commencing installation. The BDA system contractor shall repair any and all damage to the work in place caused by the BDA system contractor at no cost to the Suffolk School System.

4. System Testing and Acceptance:

Testing criteria shall be as follows:

- a. A minimum received signal level from either the amplifier or directly from the radio system shall be a minimum of -95 dBm as read by a calibrated field strength meter on the control and voice channels of the city radio system.
- b. Talk-back signal level, to the 800 MHz system from a portable radio located within the building areas of the basement, first, second floors (including corridors). The system will be designed to ensure that a minimum input signal at the bi-directional amplifier receive port of -95 dBm is received in the event that a person is down on the floor with a portable on their hip.

5. City Radio System:

The amplifier is to be designed to pass only the City of Suffolk radio system channels, as is practical. The operating frequencies and site information for the city system are available from the City of Suffolk Radio Engineer.

6. Installation Locations:

The amplifier and rooftop antenna shall be installed in the best practical location, pursuant to applicable building codes and approval by the Suffolk School System. Design and installation of the support and/or attachment of the exterior antenna to the building structure shall be the responsibility of the BDA system contractor. Roof and/or wall penetration(s) and repair(s) shall be provided by general contractor.

7. Public Safety Rated Signal Booster Specifications:

a. FCC Approved:

All equipment must include a valid Federal Communications Commission issued certification number.

b. Pass band Frequencies and Emission:

The signal booster shall be optimized to pass the following frequency bands for the City of Suffolk Radio System. Filtering necessary to protect the City of Suffolk frequencies from adjacent channel interference will be provided, with a minimum of 30 dB rejection of potential interfering channels. Certified filter characteristic curves shall be provided upon request. Generalized curves from brochures are not acceptable.

8. The amplifier should be designed to accommodate Motorola signals used by City of Suffolk.

9. Gain:

The amplifier shall have a minimum gain of 80 dB in both directions or gain sufficient to produce a -95 dBm signal throughout the building and provide reliable communications to the closest radio system site. Gain shall be adjustable without the use of external programmers or portable computers.

10. RF Connectors:

The BDA shall have N-Type female located on the cabinet.

11. Output control:

An automatic output leveling circuit shall be included for both pass bands with a minimum dynamic range of 35 dB each. This circuit shall be designed to assure Out-of-band performance as specified by the FCC.

12. Power:

The signal booster panel shall operate from 120 VAC source using internal power supplies and regulators. Connect the panel to a separate dedicated branch circuit, maximum 20 amperes. Circuit breaker shall be provided with Red color handle and Red color lockout device with BDA label.

13. Cabinet:

The signal booster and all associated filters shall be housed in a single, NEMA 1 rated, painted steel box, or equivalent. The cabinet shall be large enough to dissipate internal heat without venting the inside of the cabinet to the outside atmosphere. External or exposed filters or openings are unacceptable.

14. Degraded performance in emergencies:

The signal booster shall be designed to allow degraded performance in adverse conditions, such as high temperatures in the event heat from a nearby fire, voltage fluctuations or other abnormal conditions that may occur during an emergency. Circuits that intentionally disable the signal booster in such situations (i.e. under/over voltage, over/under current, over/under temperature, high VSWR, etc.) are not acceptable. It is the purpose of this specification to assure the maximum possible level of communications to public safety personnel depending upon the signal booster even to the extent of damaging the signal booster as long as some communications benefit can be provided during the emergency.

15. MTBF:

Under normal operating conditions, the signal booster design shall have a minimum of 5 years Mean Time Between Failure (MTBF) as determined by U.S. industry accepted statistical calculations for electronic equipment.

16. Serviceability:

The signal booster shall include permanently mounted decoupled RF test ports (samplers) so routine performance tests may be made without disconnecting coaxial cables and without removing the signal booster from service.

17. Test Points:

Independent DC Voltage test points for each amplifier section shall be included. Output level control voltage test points for each direction shall be included along with a calibrated chart of attenuation in dB corresponding to the control voltage measured. The output level control voltage shall be calibrated to provide a simple and effective method of amplifier gain adjustment at the time of installation, etc. without the need for programming devices, programming manuals, portable computers etc.

18. Service Outlet:

A standard duplex 120 VAC electrical receptacle shall be mounted inside the case for testing and servicing.

19. Modularity:

The signal booster shall be modular in design to simplify troubleshooting and allow rapid emergency service restoration with a minimum of spare parts. The modularity shall consist of independently selectable low-level amplifier stages, driver amplifiers, output level controllers, power amplifiers and independent power regulators for each direction of amplification. In the event of an RF amplifier failure, it shall be possible to bypass single amplifier stages to restore service at a reduced level. Modules that incorporate multiple, inseparable amplifier stages on a common printed circuit board assembly are not acceptable.

20. Fuses and Circuit Breakers:

All fuses and circuit breakers shall be accessible without disassembly of the signal booster or any module in the signal booster. Fuses located on printed circuit boards located within closed modules that require disassembly to replace are not acceptable.

21. Communications:

The signal booster shall be capable of transmitting alarms by the City's monitoring system. Additionally, the signal booster shall have the capability for remote access to check the booster's status and to disable the booster's transmission.

22. Proven design:

The equipment type offered shall be in current production with at least 5 years field service history. Upon request, the signal booster supplier shall furnish at least three public safety references using similar equipment in service for at least 5 years.

23. Performance Certification:

Each signal booster shall be supplied with a written record of performance tests for each specific unit by serial number. Generalized specification sheets are not acceptable.

24. Record Documents:

Concurrent with completion of the work and prior to Owner Training, the BDA contractor shall provide the Owner three (3) complete sets of Service Manuals and Record Drawings of the installation. All drawings shall be created in Microsoft Visio format (.vsd). One additional set of Record Drawings shall be provided to Virginia Beach Radio Systems Engineer.

25. Service Manuals:

Service manuals shall be supplied for each signal booster. The minimum contents of each manual shall include:

- a. Operating and installation detail.
- b. Block (sub assembly) overall circuit diagram with assembly number detail.
- c. Mechanical assembly drawing with part number detail.
- d. Detailed schematic circuit diagrams listing all components and locations.
- e. Detailed parts list.

NOTE: Equipment provided without detailed schematics and parts lists are unacceptable.

26. Technical Assistance:

The equipment vendor must have a service department that will respond to telephone or written requests for technical support at no charge to the Owner for a period on one year. This department shall be available during all normal working hours at the factory's location. Vendors are encouraged to have local technical support and shall list the nearest technical support field location and telephone numbers.

27. Warranty:

BDA vendor shall provide the Suffolk School System with a one year warranty for installation and operation of the BDA system from date of system acceptance. All equipment shall have a minimum one-year in-factory repair or replacement warranty from date of system acceptance.

END OF SECTION 275125

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SECTION 275313 - GPS WIRELESS CLOCK SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SECTION INCLUDES

- A. Transmission Systems
 - 1. GPS Receiver
 - 2. Primary Transmitter
 - 3. Satellite Transmitter
- B. Clocks
 - 1. Analog (battery)
 - 2. Analog (AC)
 - 3. Digital

1.3 REFERENCES

- A. This Technical Specification and Associated Drawings.
- B. Primex Wireless GPS Satellite Time System User Manual.

1.4 DEFINITIONS

- A. GPS: Global Positioning System, a worldwide system that employs 24 satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits atomic time, the most accurate and reliable time.

1.5 SYSTEM DESCRIPTION

- A. GPS wireless clock system shall continually synchronize clocks throughout the facility, and shall be capable of clock readouts in multiple time zones where desired.

- B. The system shall synchronize all clocks to each other. The system shall utilize GPS technology to provide atomic time. The system shall not require hard wiring. Clocks shall automatically adjust for Daylight Savings Time.
- C. Analog Clocks shall be synchronized to within 10 milliseconds 6 times per day, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronizations, so that clock accuracy shall not exceed plus or minus 0.2 seconds.
- D. The system shall include an internal clock reference so that failure of the GPS signal shall not cause the clocks to fail in indicating time.
- E. The system shall incorporate a “fail-safe” design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal operation without the need to reset the system or any component thereof.
- F. Clock locations shall be as indicated, and clocks shall be fully portable, capable of being relocated at any time.

1.6 REGULATORY REQUIREMENTS

- A. Equipment and components furnished shall be of manufacturer’s latest model.
- B. Transmitter and receiver shall comply with Part 90 of FCC rules as follows:
 - 1. This device may not cause harmful interference, and
 - 2. This device must accept interference received, including interference that may cause undesired operation.
 - 3. Transmitter frequency shall be governed by FCC Part 90.35.
 - 4. Transmitter output power shall be governed by FCC Part 90 257 (b)
- C. System shall be installed in compliance with local and state authorities having jurisdiction.

1.7 SUBMITTALS

- A. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors and finishes of clocks.
- B. Operating License: Submit evidence of application for operating license prior to installing equipment. Furnish the license, or if the license has not been received, a copy of the application for the license, to the Owner prior to operating the equipment. When license is received, deliver original license to Owner.
- C. Samples: Submit one clock for approval. Approved sample shall be tagged and shall be installed in the work at location directed.

- D. Manufacturer's Instructions: Submit complete installation, setup and maintenance instructions.
- E. Floor plans indicating the location of system transmitter(s), approved by manufacturer, will be submitted to Owner prior to installation.

1.8 SUBSTITUTIONS

- A. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.
- B. Proposed substitutions shall be identified not less than 10 days prior to bid date.
- C. Other systems requiring wiring and/or conduit between master and clocks will not be accepted.
- D. Other systems using wireless technology in an unlicensed frequency range will not be accepted.

1.9 QUALITY ASSURANCE

- A. Permits: Obtain operating license for the transmitter from the FCC.
- B. Qualifications:
 - 1. Manufacturer: Company specializing in manufacturing commercial time system products with a minimum of 30 continuous years of documented experience, including 4 years' experience producing GPS wireless time systems.
 - 2. Installer: Company with documented experience in the installation of commercial time systems.
- C. Prior to installation, a site survey must be performed to determine proper transmitter placement.

1.10 DELIVERY STORAGE AND HANDLING

- A. Deliver all components to the site in the manufacturer's original packaging. Packaging shall contain manufacturer's name and address, product identification number, and other related information.
- B. Store equipment in finished building, unopened containers until ready for installation.

1.11 PROJECT SITE CONDITIONS

- A. Clocks shall not be installed until painting and other finish work in each room is complete.

- B. Coordinate installation of GPS receiver for access to the roof or exterior side wall so that the bracket and related fasteners are watertight.

1.12 SYSTEM STARTUP

- A. At completion of installation and prior to Final Acceptance, turn on the equipment; ensure that all equipment is operating properly, and that all clocks are functioning.

1.13 WARRANTY

- A. Manufacturer will provide a 5-year warranty on GPS receiver, transmitter, and satellite transmitter. All other components will have a 1-year warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. GPS wireless clock system shall be manufactured by PRIMEX WIRELESS, INC., N3211 County Road H, Lake Geneva WI 53147 (800) 537-0464 FAX (262) 248-0061 www.primexwireless.com. **[NO SUBSTITUTE]**

2.2 SEQUENCE OF OPERATION

- A. Transmitter Operation: When power is first applied to the transmitter, it checks for and displays the software version. It then checks the position of the switches and stores their position in memory. The transmitter looks for the GPS time signal. Once the transmitter has received the GPS time, it sets its internal clock to that time. The transmitter then starts to transmit its internal time once every second. The transmitter updates its internal clock every time it receives valid time data from the GPS.
- B. Analog Clock Operation:
 - 1. Apply power or insert batteries. Follow setup procedures detailed in manufacturer's instructions.
 - 2. After initial setup, the clock will shut off the receiver. Six times each day, the microprocessor will activate the receiver and, starting with the stored channel, it will again look for a valid time signal. If necessary, the clocks will resynchronize to the correct time.
 - 3. If the clock has not decoded a valid time signal for a pre-determined number of days, it will go to a sleep mode. Non-signal reception can be caused by low battery voltage. If this occurs, replace the batteries.
- C. Digital Clock Operation:

1. Apply power or insert batteries. Follow setup procedures detailed in manufacturer's instructions.
2. After initial setup, the clock will shut off the receiver. Six times each day, the microprocessor will activate the receiver and, starting with the stored channel, it will again look for a valid time signal. If necessary, the clocks will resynchronize to the correct time.
3. If the clock has not decoded a valid time signal for a pre-determined number of days, it will go to a step mode. Non-signal reception can be caused by low battery voltage. If this occurs, replace the batteries.

2.3 EQUIPMENT

- A. General: The clock system shall include a transmitter, a roof or window mounted GPS receiver, indicating clocks, and all accessories for complete operation.
- B. GPS Receiver: GPS roof-mounted, with 10-foot cable (3m) attached (additional Primex Wireless extension cable available: 50ft (15.25m), 100 ft (30.5m), and 200 ft (61m).
 1. The GPS Receiver shall be a complete GPS receiver, including antenna in a waterproof case, designed for roof or outdoor mounting. Provide mounting bracket for attachment to roof structure.
 2. The GPS Receiver cable must be plenum rated where required by local code.
- C. Transmitter: PRIMEX WIRELESS Model 14400, consisting of wireless transmitter with GPS receiver, a surge suppressor/battery backup, and a mounting shelf. Unit shall obtain current atomic time from satellite. The clock system shall transmit time continuously to all clocks in the system.
 1. Transmission:
 - a. Frequency Range: 72.100 to 72.400 MHz.
 - b. Transmission Power: 1-watt (30dBm) maximum
 - c. Radio technology: narrowband FM
 - d. Number of channels: 16
 - e. Channel bandwidth: 20 kHz maximum
 - f. Transition mode: one-way communication
 - g. Data rate: 2 KBps
 - h. Operating range: 32°F to 158°F (0°C to 70°C).
 2. Transmitter:
 - a. Transmitter output power: +26 to +30 dBm
 - b. Frequency deviation: ± 4 kHz
 - c. Transmitter power requirements: 120 VAC 60 Hz
 - d. Internal power requirements: 5 VDC
 - e. Carrier frequency stability: ± 20 ppm
 3. Transmitter shall have 16 selectable channels to assure interference-free reception.

4. Transmitter shall have the following switches:
 - a. Time zone adjustment switches for all time zones in the world. Includes: Eastern, Central, Mountain, Pacific, Alaska, and Hawaii.
 - b. Daylight Saving Time bypass switch.
 - c. 12-hour or 24-hour display.
 5. Transmitter housing shall be black metal case, 16-3/4" by 12" by 1-7/8" in size.
 6. Antenna shall be 46" high, commercial type, mounted on top center of transmitter housing. Antenna gain shall be < 2.2 dB. Antenna polarization shall be vertical.
 7. Transmitter housing shall incorporate a display which shall include the following:
 - a. Time readout
 - b. AM and PM indicator if 12-hour time display is set
 - c. Day and date readout
 - d. Indicator for daylight savings or standard time
 - e. LED which shall flash red in event of reception problem
 - f. GPS reception indicator
 8. Transmitter shall contain an internal clock such that failure of reception from the GPS will not disable the operation of the clocks.
- D. Power supply (included):
1. Input: 120-volt AC 50/60 Hz, 0.4 amp.
 2. Output: 9-volt DC, 2.0 amp.
- E. Surge Protector/Battery Backup (included):
1. Input: 120-volt AC 60 Hz \pm 1 Hz.
 2. Output: 120-volt AC, 500VA, 300 watts
 3. Surge Energy Rating: 365 joules
- F. Additional Equipment:
1. Wireless Receiver Switches: Switches shall receive time packets from the Primary Transmitter and relay the synchronized time to the Satellite Transmitter connected to it. The unit shall include the following:
 - a. Antenna mounted on top of the switch housing, 11-1/2" long.
 - b. Power Supply: Input: 120 VAC 50/60 Hz, 0.4 amps
Output: 9-volt DC, .25 amps
 - c. RS 232 data cable, 5' long
 - d. Daylight Savings Time bypass switch
 - e. Dimensions: 4-1/4" long, 5-3/4" wide, 1-1/4" deep.
 - f. Weight: 12 ounces (.34kg)
 - g. Operating Range: 32°F to 158°F (0°C to 70°C)

2. Satellite Transmitters Primex Wireless Model 14401: Satellite Transmitters shall receive the signal from the Wireless Receiver Switches and transmit the signal to the devices in its vicinity, which are out of the range from the Master Transmitter. The unit shall include the following:
 - a. Antenna mounted on top of the housing, 46" long.
 - b. Wireless Receiver Switch.
 - c. Power Supply: Input: 120 VAC, 50/60 Hz, 0.4 amp
Output: 9-volt DC, 2.0 amps.
 - d. 6-foot cord
 - e. Surge Suppressor/Battery Backup
 - f. Mounting Shelf.
 - g. Transmission Power: 1 watt maximum
 - h. 72 MHz frequency.
- G. Traditional Analog Clocks (Battery): Analog clocks shall be wall mounted. Clocks shall have polycarbonate frame and polycarbonate lens. Face shall be white. Hour and minute hands shall be black.
 1. 9" diameter analog clock: PRIMEX Model 14280
 2. 12-1/2" diameter analog clock: PRIMEX Model 14155
 3. 16" diameter analog clock: PRIMEX Model 14163
 4. 24" diameter analog clock: PRIMEX Model 14346
 5. Additional colors, finishes, and dial faces are available from manufacturer.
 6. Analog clocks shall be battery-operated, and shall have minimum 5-year battery life.
 7. Analog clocks shall be capable of automatically adjusting for Daylight Saving Time. An on-off switch located on the transmitter shall disable this function if desired.
 8. Time shall be automatically updated from the transmitter 6 times per day.
 9. Analog clocks shall remember the time during changing of batteries.
 10. 9" and 12.5" analog clocks shall have a tamper-proof/theft-resistant clock lock mounting slots.
 11. Provide two alkaline batteries. (9" C cells, 12.5", 16" D cells and 24" C cells)
 12. Analog clock receivers shall be as follows:
 - a. Receiver sensitivity: >-110 dBm
 - b. Receiver power: two alkaline D-cells
 - c. Antenna type: internal
 - d. Antenna gain: -7 dBd
 13. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded.
 14. Analog clock faces shall bear Owner's logo as indicated.
- H. Traditional Analog Clocks (AC): Analog clocks shall be wall mounted. Clocks shall have polycarbonate frame and polycarbonate lens. Face shall be white. Hour and minute hands shall be black.
 1. 12-1/2" diameter analog clock, 24 VAC: PRIMEX Model 14323
 2. 12-1/2" diameter analog clock, 24 VAC, non-DST: PRIMEX Model 14324.

3. 12-1/2" diameter analog clock, 120 VAC: PRIMEX Model 14306
 4. 12-1/2" diameter analog clock, 120 VAC, non-DST: PRIMEX Model 14308
 5. Additional colors, finishes, and dial faces are available from manufacturer.
 6. Analog clocks shall be AC powered (24 VAC or 120 VAC). Clocks must have an 18" pigtail to connect to power source.
 7. Analog clocks shall be capable of adjusting for Daylight Savings Time. Non-DST models should be selected for areas that do not observe Daylight Savings Time.
 8. Time shall be automatically updated from the transmitter 6 times per day.
 9. If power is interrupted, the clock will stop until power resumes. Upon resumption of power, the clock will self-correct to the current time.
 10. Clocks shall have a tamper-proof/theft-resistant clock lock mounting slots.
 11. Analog clock receivers shall be as follows:
 - a. Receiver sensitivity: >-110 dBm
 - b. Receiver power: 24 VAC or 120 VAC (see model #)
 - c. Antenna type: internal
 - d. Antenna gain: -7 dBd
 12. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded.
 13. Analog clock faces shall bear Owner's logo as indicated.
- I. Wire Guards: Provide one for each analog clock as follows:
1. Model No. 14131, 14" by 14" size, for nominal 12-1/2" diameter analog clocks.
 2. Model No. 14123, 18" by 18" size, for 16" diameter analog clocks.
- J. Digital Clocks: Provide PRIMEX WIRELESS Model [____], [4"], [2.5"] 4-Digit display clocks. Clocks shall have polycarbonate frame and polycarbonate lens. LED digits shall be red or green. Overall dimensions: 18" long, 8" wide, 3" deep.
1. Digital clocks must be able to receive synchronized time signal from PRIMEX WIRELESS master or satellite transmitter.
 2. Digital clocks must have time and date option.
 3. Digital clocks shall be capable of automatically adjusting for Daylight Savings Time.
 4. Power Supply: [120 VAC, 50-60 cycle] [24 VAC or 24 VDC].
 5. Digital clocks must be viewable from 150'.
 6. Provide brackets as required for double face mounting.
- K. Cable Connection Sealant: Radio Shack Coaxial Cable Connector Sealant 278-1645, or approved electrical grade silicone sealant.
- L. Digital Clock Power Supplies: Provide power supplies located throughout building as required to serve all clocks. Provide circuit breakers in electrical panels as required to serve power supplies, spare circuit breakers shall not be used. Provide low voltage wiring as required between power supplies and digital clocks. Provide power supplies as recommended by PRIMEX WIRELESS.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.
- B. Verify that 120-volt electrical outlet is located within 6' of location of transmitter and the outlet is operational and properly grounded.

3.2 INSTALLATION

- A. GPS Unit: Install on roof in location indicated, in clear view of the sky. Install unit in location free from standing water, and above accumulations of leaves or debris. Seal cable connection to GPS with cable connection sealant. Any added cable lengths must be protected from outside elements.
- B. Transmitter:
 - 1. Locate the transmitter where indicated, a minimum of 2' to 3' feet above the floor, away from large metal objects, such as filing cabinets, lockers or metal framed walls. Transmitter(s) will be placed at locations indicated below:
 - 2. Attach receiver to transmitter using cable.
 - 3. Connect antenna to transmitter, using care not to strip threads.
 - 4. Connect power supply to the transmitter.
 - 5. Set the channel number on the display to correspond to the FCC license.
 - 6. Plug power supply into electrical outlet.
- C. Analog clocks (battery): Perform the following operations with each clock:
 - 1. Install D-cell batteries.
 - 2. Set clock to correct time in accordance with manufacturer's instructions.
 - 3. Observe analog clock until valid signals are received and analog clock adjusts itself to correct time.
 - 4. Install the analog clock on the wall in the indicated location, plumb, level and tight against the wall. If using 12-1/2" clock, attach using clock-lock hanging method and suitable fasteners as approved by clock manufacturer.
- D. Analog clocks (AC): Perform the following operations with each clock:
 - 1. Apply power (24 VAC or 120 VAC)
 - 2. Observe clock until valid time signals are received and analog clock adjusts itself to correct time.
 - 3. Install the analog clock on the wall in the indicated location, plumb, level, and tight against the wall. Attach using clock-lock hanging method and suitable fasteners as approved by clock manufacturer.

- E. Wire Guards: Secure to wall, using approved theft-resistant fasteners.

3.3 ADJUSTING

- A. Prior to Final Acceptance, inspect each clock, adjust as required, and replace parts which are found defective.

3.4 CLEANING

- A. Prior to Final Acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by clock manufacturer. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

3.5 DEMONSTRATION

- A. Provide training to Owner's representative on setting and adjusting clocks, replacing batteries and routine maintenance.

3.6 PROTECTION

- A. Protect finished installation until Final Acceptance of the project.

3.7 TESTING

- A. All devices must be tested at their operational location under normal operational conditions to assure reception of signal.

END OF SECTION 275313

SECTION 275316 - ELEVATOR EMERGENCY TWO-WAY COMMUNICATION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SCOPE OF WORK

- A. Provide and install a complete and fully operational Emergency Communication System as specified herein and indicated on the drawings. The system shall provide both visual and audible indications of persons in distress as well as voice communications to the specified areas. Refer to IBC Section 1009.8.
 - 1. The system shall be a vandal-resistant system providing two-way communications between all emergency two-way communication and the master station throughout the building.
 - 2. Station shall be fabricated from #16 AWG stainless steel and shall have engraved lettering. Stamped lettering shall not be permitted.
 - 3. Station and signage shall also be provided with lettering in Braille.
 - 4. Station shall be provided with a stainless-steel and fastened with tamper-proof hardware. Station shall be equipped with a 3" x 3" help button and a light to indicate that help is on the way. A second light shall illuminate to indicate that the system is in operation.
- B. The work indicated in this Section shall be provided complete, suitable for its intended use, and shall be fully incorporated into the work.
- C. The provisions of the Contract Documents apply to the work of this Section, and shall be carefully examined, for their applicability to this Section, to ensure a complete installation.
- D. Provide this work in accordance with the Contract Documents, NFPA 70-NEC (and the pertinent sections of the other references), and the manufacturer's requirements and recommendations. Conflicts shall be as determined by the Architect/Engineer.
- E. All accessories required or recommended by the references or the manufacturer shall be provided.

1.3 SUBMITTALS

- A. Submittals concerning the work of this Section are only required as stipulated within this Section. Extraneous submittals will be returned with no action.
- B. Required Submittals:
 - 1. Product Data on Equipment.
 - 2. Product Data on Operating Instructions Signage.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Amplifier: The Amplifier shall provide control amplification and power circuits for system operation. The unit shall be housed in a rugged extruded steel case and shall have integrated circuit amplification. The call tone shall be an integrated circuit with oscillator amplification at 400 Hz. The Amplifier shall be driven from 16-volt transformer.
- B. Master Station: The Master Station shall be provided with one indication light and selector switch for the Emergency Communication System connected. The unit shall incorporate Talk/Listen switches for control of all voice conversations. When the Talk/Listen switch is used, an indicator light shall illuminate on the area station indicating that help is on the way. The master station shall have a timed automatic telephone dial-out capability to a monitoring location or 911.
- C. Area Station: The Area Station shall be installed as indicated on the drawings. Each station shall be flush mounted. The Area Station shall be provided with a 3" x 3" help button, label reading "Emergency Communication System – Push for Help," and two (2) indication lights. The units shall provide audible and visual indication of persons in distress at the Master Station. Two-way voice communications shall be established from the Master Station allowing response from the Area Station to be hands free.
- D. Directions for the use of the two-way communication system: Instructions for summoning assistance via the two-way communication system and written identification of the location shall be posted adjacent to the two-way communication systems. Signage shall comply with the ICCA117.1 requirements for visual characters.
- E. Signage for both the help button label and the instructions for use shall comply with the following:
 - 1. Character Proportion: Letters and numbers on signs shall have a width-to-height ratio between 1:5 and 1:10.
 - 2. Color Contract: Characteristics and symbols shall contrast with the background – either light characters on a dark background or dark characters on a light background.
 - 3. Characters or symbols: Letters, numbers, symbols, or pictographs on signs shall be raised or incised 1/32" minimum and shall be sans serif characters. Raised characters shall be at least 5/8" high, but no higher than 2".

4. Mounting Height: The top of the posted instructions shall be no more than 54" above the finished floor.
5. Provide grade 2 Braille lettering in addition to text.

PART 3 - EXECUTION

3.1 EXECUTION

- A. Perform this work in accordance with acknowledged industry and professional standards and practices, and the procedures specified herein.
 1. Provide and install all material, devices, components, and equipment for complete operational systems.
 2. Maintain a competent supervisor and supporting technical personnel, acceptable to the Owner, during the entire installation. Change of the supervisor during the project shall not be acceptable without prior written approval from the Architect/Engineer.
 3. Coordinate all efforts with those of related trades. In the event of any conflicts, delayed or important preparatory work by others, notify the Owner or the Owner's agent; the Owner's or Owner's agent's decision shall be binding.
 4. All wiring shall be installed in conduit. Provide pull wire in all empty conduit.
 5. The Contractor shall be responsible for reviewing and coordinating conduit installation for the system with the Division 26 Contractor.
 6. Connect the control panel to a separate dedicated branch circuit, maximum 20 amperes. The circuit breaker serving the control panel shall be provided with Red color lockout device.

END OF SECTION 275316

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SECTION 282300 - CLOSED-CIRCUIT TELEVISION SURVEILLANCE SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specifications Sections, and Section 260100, "Electrical General Provisions," apply to this Section.
- B. Comply with Section 018113 "Sustainable Design Requirements" for Green Globes requirements.

1.2 SCOPE OF WORK

- A. This Section of the Specifications describes the material and installation procedures to be followed for furnishing and installing the Closed Circuit Television (CCTV) Surveillance Systems as outlined and shown on the drawings, and as stated in this Section of the Specifications.
- B. This Section includes the equipment, programming, supervision, and coordination of installation of Closed Circuit Television (CCTV) Surveillance Systems equipment as shown on the drawings, described herein, and as may be required for a complete and fully operational system. Conduit rough-in, backboxes, pull wires, 120VAC shall be provided as required. The Engineer shall determine compliance of substitute submittals to this Specification.
- C. It shall be the responsibility of the Contractor to coordinate and verify exact installation and cable requirements and provide same as if fully specified herein.
- D. The Contractor shall install the systems as specified herein and indicated on the drawings and shall furnish all labor, material, tools, scaffolds, erection equipment, services and other items of expense as necessary as a part of this Contract. This Contract further includes placing the systems into operation and properly testing, adjusting, and balancing all items of equipment as specified and as approved by the Engineer.
- E. Conform to the requirements of all rules, regulations, and codes of local, state, and federal authorities having jurisdiction. Conform to the NEC and NECA "Standards of Installation."
- F. Perform the work in a first-class, substantial, and workmanlike manner. Any materials installed which do not present an orderly and neat workmanlike appearance shall be removed and replaced when so directed by the Engineer at the Contractor's expense.
- G. Coordinate the work of all trades.

- H. Provide and arrange conduit, wiring, equipment, and other work generally as shown, providing proper clearances and access. Carefully examine all Contract Drawings and fit the work in each location without substantial alteration. Where departures are proposed because of field conditions or other causes, prepare and submit detailed drawings to the Engineer for approval.
- I. Installation shall be made in accordance with the drawings, Specifications, and the following:
 - NEC Article 760
 - NFPA 72A
 - NFPA 72E
 - Local Codes and Authorities Having Jurisdiction
 - Americans with Disabilities Act 101-336
- J. The Contractor shall provide all labor, materials, equipment, and supplies to fabricate, install, test, and place in operation the CCTV Surveillance System, as called for in these Specifications, shown on the drawings, or required to provide a complete and operable system.
- K. All material and equipment shall be properly stored and protected until installed.
- L. All material and equipment shall be new and of the quality noted or specified. All material, equipment, and work of inferior quality will be rejected. Rejected materials and equipment shall be removed from the job site and immediately replaced, and unaccepted work shall be made good, all by the Contractor at his own expense. The Engineer will decide upon the quality of material and equipment provided and of the work performed.

1.3 CONTRACTOR QUALIFICATIONS

- A. Contractor shall understand fully all aspects of the system requirements, as to equipment to be supplied, installation requirements, total system operation desired, and shall meet fully all these requirements with no exceptions.

1.4 SUBMITTALS, DRAWINGS, EQUIPMENT STORAGE, WARRANTY, TRAINING

- A. All shop drawings shall be CAD generated, 1/8" scale. Provide drawing files on CD ROM disks along with printed copies of shop drawings in each submittal. Closed Circuit Televisions Surveillance Systems shop drawings shall not be combined with any other auxiliary system shop drawings.
- B. Drawings shall indicate the following: building floor plan, location and type of devices, wire quantities, locations of CCTV surveillance equipment and device connection details.
- C. Submit manufacturer's installation instructions, including backbox requirements, for each piece of equipment.
- D. Submit manufacturer's operating instructions and maintenance data.

- E. Quantities and types of cameras required are as per drawings.
- F. The work described in this Specification consists of all labor, materials, equipment, and services necessary and required to complete and test CCTV surveillance system. Any and all materials and labor not shown on drawings, but required for proper performance and operation as specified, shall be furnished and installed as if fully specified herein.
- G. The Contractor shall confirm that within a 50-mile distance of the job site there is an established office which stocks a full complement of parts and offers service during normal working hours on all equipment to be furnished, and that the agency will supply parts without delay and at reasonable cost. The agency shall provide emergency service for all after-hour calls.
- H. A complete schedule and catalog data (CD) and shop drawings (SD) shall be submitted for each piece of material and equipment required for this project.
- I. The following types of equipment and materials require shop drawing submittal but the list below shall not be construed as all inclusive:
 - Each type of camera
 - Each type of camera housing
 - Each type of mounting bracket
 - Each type of camera lens
 - Each type of switches
 - Each type of cable (plenum and non-plenum)
 - Each type of power supply
 - Each type of transformer
- J. Upon completion of the work and at a time designated by the Owner, the services of a competent person(s) shall be provided to instruct the Owner's representative in operation and maintenance of each system.
- K. All equipment shall be stored and protected from the weather, humidity, temperature variation, dirt, dust, and other contaminants.
- L. The Contractor shall coordinate this work with the existing architectural, structural, mechanical, plumbing, and electrical elements of the building plans and work in order to eliminate any interference. Report any discrepancies found, as soon as possible, after discovery, to the Engineer.

1.5 NOTICES AND FEES

- A. The Contractor shall give all required notices, obtain all necessary permits, and pay all required fees.

PART 2 - PRODUCTS

2.1 CLOSED CIRCUIT TELEVISION (CCTV) SURVEILLANCE SYSTEM EQUIPMENT

A. The following materials/equipment form the basis for the design of this project and therefore set the minimum specifications:

1. PANASONIC WV-CP234, 1/3" color CCD camera, 480 TVL high resolution, 24 VAC power.
2. PANASONIC WV-LZ62/2, 1/3" variable focal lens, 3.5-8 mm focal length for use with WV-CP234, 1/3" color CCD camera.
3. PELCO EH3512-2 enclosure with 24 VAC heater, defroster and blower for use with WV-CP234, 1/3" color CCD camera.
4. PELCO SS3512 sun shroud for the PELCO EH3512-2 enclosure.
5. PELCO EM2400 wall mount with cable feed through.
6. PELCO SD5BC-PG-EO Spectra II 1/4" premier integrated dome system with camera, lens, exterior housing, heater and sunshield, 470 TVL resolution, 24 VAC power.
7. PELCO IWM-GY wall mount for use with Spectra II dome.
8. PELCO CM400 corner mount adapter for use with the PELCO IWM-GY wall mount.
9. PELCO SD5AC-F0 integrated dome system with PELCO SD5 ceiling plate and power supply.
10. SONY SCC-C104 color camera, PELCO E2100P Ceiling housing, PELCO E2100 ceiling plate, PELCO E2100 ceiling plate, COMPUTAR TG2Z3514FCS auto iris lens and power supply.
11. SONY SCC-C104 color camera, PELCO EM100 ceiling housing, PELCO EM2400 wall mount, COMPUTAR TG2Z3514FCS auto iris lens and power supply.
12. PANASONIC WV-CK1420 spot monitor.
13. PANASONIC WV-CK2020 20" color monitor with 500+ TVL resolution.
14. KALATEL DVMRe 160B, 16 input triplex digital multiplexer/recorder.
15. Desktop Rack Cabinet.
16. KALATEL KTD-83-16 data signal distributor.
17. KALATEL KTD-405 controller keypad.
18. STEALTH LABORATORIES TIB-2496 transformer, 24V, 4 amps.
19. STEALTH LABORATORIES TIB-2460 transformer, 24V, 2.4 amps.
20. Miscellaneous mounting hardware and connectors.

B. The quantities of materials/equipment required by this project are the responsibility of the Contractor, except the number of cameras required shall be that indicated on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All circuits for the CCTV shall be plenum-type cable throughout the school.

B. Conduit stub-ups, standard backboxes, backbox rough-in, and penetrations are a requirement of this project and shall be provided by the project.

- C. System test shall only be performed by an individual who has attended a manufacturer's seminar for installing and testing the CCTV surveillance system specified herein.
- D. Test reports shall include but not limited to:
 - 1. A complete list of equipment installed.
 - 2. Indicated that all equipment has been properly installed and functions have been tested according to these Specifications.
 - 3. Technician's name, the date of the test, and the branch that they represent.
- E. Final Acceptance will require the Contractor to deliver the following:
 - 1. Supply parts and service repair manuals and make parts readily available.
 - 2. Three (3) copies of the operating instructions and system maintenance manuals.
 - 3. Three (3) sets of record drawings.
 - 4. 3-1/2" floppy disk of record drawings (one per building) in ACAD R14 format.
 - 5. Three (3) copies of the final test reports.
 - 6. Three (3) copies indicating the name and phone number of a person to contact in the event of equipment failure, and date when system warranty will be terminated.
 - 7. Three (3) sets of data sheets for each piece of equipment supplied.

END OF SECTION 282300

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SECTION 311000- SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing above- and below-grade site improvements.
3. Temporary erosion- and sedimentation-control measures.

1.3 DEFINITIONS

- A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.
- D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
- E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings.
- F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

- A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain on Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 QUALITY ASSURANCE

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

1.6 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Improvements in Adjoining Right-of-Way: Authority for performing work indicated in the adjoining right-of-way will be obtained by Owner before award of Contract.
 - 1. Do not proceed with work on adjoining property until directed by Architect.
- C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- D. Utility Locator Service: Notify Miss Utility for area where Project is located before site work.
- E. Do not commence site operations until temporary erosion- and sedimentation-control and plant-protection measures are in place and property functioning.
- F. The following practices are prohibited within protection zones:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Foot traffic.
 - 4. Erection of sheds or structures.
 - 5. Impoundment of water.
 - 6. Excavation or other digging unless otherwise indicated.
 - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- G. Do not direct vehicle or equipment exhaust towards protection zones.
- H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.
- I. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving for Sitework for Sitework" and Division 32 Section "Turf and Grasses".

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1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly identify trees, shrubs, and other vegetation to remain. Flag each tree trunk at 54 inches above the ground.
- C. Protect existing site improvements to remain from damage during construction.
 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

- A. General: Protect trees and plants remaining on-site according to requirements in Division 01.
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.4 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
 1. Arrange with utility companies to shut off indicated utilities
- B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 1. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
 2. Use only hand methods for grubbing within protection zones.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water and temporary seed. Remove excess topsoil from site.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.
- C. If regulated waste is encountered, it shall be directly loaded and hauled offsite for disposal in a facility permitted to accept such material.

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END OF SECTION 311000

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SECTION 312000 - EARTH MOVING FOR SITEWORK

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. Preparing subgrades for walks, pavements, turf and grasses, and plants.
- 2. Excavating and backfilling for buildings and structures.
- 3. Subbase course for concrete walks.
- 4. Subbase course and base course for asphalt paving.
- 5. Excavating and backfilling trenches for utilities and pits for buried utility structures.

1.3 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.
- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Engineered Fill layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
 - 2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
 - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized

excavation, as well as remedial work directed by Architect, shall be without additional compensation.

- G. Fill: Soil materials used to raise existing grades.
- H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct preexcavation conference at Project site.
 - 1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
 - a. Personnel and equipment needed to make progress and avoid delays.
 - b. Coordination of Work with utility locator service.
 - c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
 - d. Extent of trenching by hand or with air spade.
 - e. Field quality control.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
 - 1. Geotextiles.
 - 2. Controlled low-strength material, including design mixture.
 - 3. Warning tapes.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

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1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698.

1.7 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.8 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Improvements in Adjoining Right-of-Way: Authority for performing work indicated in the adjoining right-of-way will be obtained by Owner.
- C. Utility Locator Service: Notify "Miss Utility" for area where Project is located before beginning earth moving operations.
- D. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 31 Section "Site Clearing," are in place.
- E. Do not commence earth moving operations until plant-protection measures specified in Division 01 Section "Temporary Tree and Plant Protection" are in place.
- F. The following practices are prohibited within protection zones:
 1. Storage of construction materials, debris, or excavated material.
 2. Parking vehicles or equipment.
 3. Foot traffic.
 4. Erection of sheds or structures.
 5. Impoundment of water.
 6. Excavation or other digging unless otherwise indicated.
 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- G. Do not direct vehicle or equipment exhaust towards protection zones.
- H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups SP, SP-SM AND SM with less than 20 percent fines, according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GW, GP, GM, SP, GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.
- F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve. Engineered Fill material shall be coordinated with the structural design.
- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- H. Drainage Course: See Engineered Fill.
- I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.
- J. Sand: ASTM C 33; fine aggregate.
- K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
 2. Grab Tensile Strength: 157 lbf; ASTM D 4632.
 3. Sewn Seam Strength: 142 lbf; ASTM D 4632.
 4. Tear Strength: 56 lbf; ASTM D 4533.
 5. Puncture Strength: 56 lbf; ASTM D 4833.
 6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
 7. Permittivity: 0.2 per second, minimum; ASTM D 4491.
 8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
- B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Survivability: Class 2; AASHTO M 288.
 2. Grab Tensile Strength: 247 lbf; ASTM D 4632.
 3. Sewn Seam Strength: 222 lbf; ASTM D 4632.
 4. Tear Strength: 90 lbf; ASTM D 4533.
 5. Puncture Strength: 90 lbf; ASTM D 4833.
 6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
 7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
 8. UV Stability: 50 percent after 500 hours exposure; ASTM D 4355.

2.3 ACCESSORIES

- A. Detectable Trace Wire:
1. Install electrically continuous trace wire to be used for locating pipe with an electronic pipe locator after installation.
 2. Trace wire to be fourteen (14) gauge minimum solid copper with thermoplastic insulation recommended for direct burial. Wire connectors to be 3M DBR, or approved equal, and shall be watertight to provide electrical continuity.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
- B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth.
 - 1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
 - a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

3.4 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
 - 2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
 - 1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 - 2. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.6 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
 - 1. Clearance: 12 inches each side of pipe or conduit.
- C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
 - 1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- D. Trenches in Tree- and Plant-Protection Zones:
 - 1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 - 2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
 - 3. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

3.7 SUBGRADE INSPECTION

- A. Notify Architect when excavations have reached required subgrade.
- B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 - 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
 - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.9 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 - 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 - 2. Surveying locations of underground utilities for Record Documents.
 - 3. Testing and inspecting underground utilities.
 - 4. Removing concrete formwork.
 - 5. Removing trash and debris.
 - 6. Removing temporary shoring and bracing, and sheeting.
 - 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.11 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Backfill voids with satisfactory soil while removing shoring and bracing.

- D. Place and compact initial backfill of subbase material , free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
 - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- E. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- F. Trace wire shall be installed in the same trench and inside bored holes and casing with pipe during pipe installation. It shall be secured to the pipe as required to insure that the wire remains adjacent to the pipe. The trace wire shall be securely bonded together at all wire joints with an approved watertight connector to provide electrical continuity, and it shall be connected to surface features such as hydrants, valve boxes, or other.
- G. The wire shall be installed in such a manner as to be able to properly trace all water mains without loss or deterioration of signal or without the transmitted signal migrating off the tracer wire.
- H. At the point of connection between cast or ductile iron water mains, with any non iron water main, the tracer wire shall be properly connected to the iron pipe with a cad weld or approved equivalent. Tracer wire welds shall be completely sealed with the use of an approved mastic type sealer specifically manufactured for underground use. Mastic shall be applied in a thick coat a minimum of 2 inches thick and shall be protected from contamination by the backfill material with the use of a plastic membrane.
- I. Tracer wire shall be laid flat and securely affixed to the pipe at 10 foot intervals. The wire shall be protected from damage during the execution of the works. No breaks or cuts in the tracer wire or tracer wire insulation shall be permitted. At water service saddles, the tracer wire shall not be allowed to be placed between the saddle and the water main.

3.12 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory soil material.
 - 2. Under walks and pavements, use satisfactory soil material.
 - 3. Under steps and ramps, use engineered fill.
 - 4. Under building slabs, use engineered fill.
 - 5. Under footings and foundations, use engineered fill.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698 :
 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 100 percent.
 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
 3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
 4. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

3.15 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated. Contractor shall determine quantities of cut and fill in order to grade site to elevations shown on the Civil Drawings. Any excess material will be removed from the site in accordance with this section. Any imported material needed to bring site to grades shown on the Civil Drawings shall be approved by the Geotechnical Engineer prior to bringing such material on site. Importation of soil or removal of soil, in order to bring site into conformance with site plan grades and elevations, is included in this contract and no additional compensation shall be considered by the Owner's Representative.
 1. Provide a smooth transition between adjacent existing grades and new grades.
 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 1. Turf or Unpaved Areas: Plus or minus 1 inch.
 2. Walks: Plus or minus 1 inch.
 3. Pavements: Plus or minus 1/2 inch.

- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.16 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
 - 1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 - 2. Place base course material over subbase course under hot-mix asphalt pavement.
 - 3. Shape subbase course and base course to required crown elevations and cross-slope grades.
 - 4. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
 - 5. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 - 6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.
- C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.17 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 - 1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
 - 2. Determine that fill material and maximum lift thickness comply with requirements.
 - 3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.
- B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of

other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

- E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
 - 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
 - 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
 - 3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.
- F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.
- G. Contractor shall perform a continuity test on all trace wire in the presence of the Engineer or Owner's representative. If the trace wire is found to be not continuous after testing, Contractor shall repair or replace the failed segment of the wire.

3.18 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.
 - 1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 312100 - EARTH MOVING FOR BUILDINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for slabs-on-grade.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Excavating well hole to accommodate elevator-cylinder assembly.

B. Related Requirements:

1. Section 018113 "Sustainable Design Requirements – Green Globes" for Green Globes requirements.
2. Section 013200 "Construction Progress Documentation" for recording preexcavation and earth-moving progress.
3. Section 312000 "Earth Moving for Sitework" for general site preparation requirements.
4. Section 311000 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.

1.2 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

C. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

D. Fill: Soil materials used to raise existing grades.

E. Rock:

1. Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. (0.76 cu. m) for bulk excavation or 3/4 cu. yd. (0.57 cu. m) for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
 - a. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- (1065-mm-) maximum-width, short-

tip-radius rock bucket; rated at not less than 138-hp (103-kW) flywheel power with bucket-curling force of not less than 28,700 lbf (128 kN) and stick-crowd force of not less than 18,400 lbf (82 kN) with extra-long reach boom.

- F. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other fabricated stationary features constructed above or below the ground surface.
- G. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- H. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct preexcavation conference at Project site.
 - 1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
 - a. Personnel and equipment needed to make progress and avoid delays.
 - b. Coordination of Work with utility locator service.
 - c. Field quality control.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
 - 1. Classification according to ASTM D2487.
 - 2. Laboratory compaction curve according to ASTM D698.

1.5 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

1.6 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

- B. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.
- C. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 015000 "Temporary Facilities and Controls" and Section 311000 "Site Clearing" are in place.
- D. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.
- E. The following practices are prohibited within protection zones:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Foot traffic.
 - 4. Erection of sheds or structures.
 - 5. Impoundment of water.
 - 6. Excavation or other digging unless otherwise indicated.
 - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- F. Do not direct vehicle or equipment exhaust towards protection zones.
- G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487, or a combination of these groups; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
 - 1. Liquid Limit: 20.
 - 2. Plasticity Index: 6.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

- E. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and zero to 5 percent passing a No. 8 (2.36-mm) sieve.
- F. Sand: ASTM C33/C33M; fine aggregate.
- G. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:
 - 1. Red: Electric.
 - 2. Yellow: Gas, oil, steam, and dangerous materials.
 - 3. Orange: Telephone and other communications.
 - 4. Blue: Water systems.
 - 5. Green: Sewer systems.
- B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:
 - 1. Red: Electric.
 - 2. Yellow: Gas, oil, steam, and dangerous materials.
 - 3. Orange: Telephone and other communications.
 - 4. Blue: Water systems.
 - 5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

- A. Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
- B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
- D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

3.3 EXPLOSIVES

- A. Explosives:
 - 1. Do not use explosives.

3.4 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
 - 2. Pile Foundations: Stop excavations 6 to 12 inches (150 to 300 mm) above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
 - 3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
 - 1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 - 2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.5 EXCAVATION FOR ELEVATOR CYLINDER

- A. Drill well hole plumb in elevator pit to accommodate installation of elevator-cylinder assembly. Coordinate with applicable requirements for diameter and tolerances in Section 142400 "Hydraulic Elevators."
- B. Provide well casing as necessary to retain walls of well hole.

3.6 SUBGRADE INSPECTION

- A. Notify Architect when excavations have reached required subgrade.
- B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes) to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
 - 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.7 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.8 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 - 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 - 2. Testing and inspecting underground utilities.
 - 3. Removing concrete formwork.
 - 4. Removing trash and debris.
 - 5. Removing temporary shoring, bracing, and sheeting.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.9 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under steps and ramps, use engineered fill.
 - 2. Under building slabs, use engineered fill.
 - 3. Under footings and foundations, use engineered fill.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.10 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.11 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D698:
 - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.

3.12 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
 - 1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 - 2. Place drainage course 6 inches (150 mm) or less in compacted thickness in a single layer.

3. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.13 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
 2. Determine that fill material classification and maximum lift thickness comply with requirements.
 3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.
- B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- E. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:
 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. (186 sq. m) or less of paved area or building slab but in no case fewer than three tests.
 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet (30 m) or less of wall length but no fewer than two tests.
- F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

END OF SECTION 312100

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SECTION 312319 - DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes construction dewatering.

1.2 PREINSTALLATION MEETINGS

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

1.3 FIELD CONDITIONS

- A. Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.
1. Make additional test borings and conduct other exploratory operations necessary for dewatering in accordance with the performance requirements.
- B. The geotechnical report is included elsewhere in Project Manual
- C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
 - 1. Prevent surface water and subsurface or groundwater from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
 - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Provide temporary grading to facilitate dewatering and control of surface water.
- D. Protect and maintain temporary erosion and sedimentation controls during dewatering operations.

3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
 - 1. Space well points or wells at intervals required to provide sufficient dewatering.
 - 2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.
- C. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

- A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

- B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
 - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
 - 2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
 - 3. Maintain piezometric water level a minimum of 24 inches below bottom of excavation.
- C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.
- D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

3.4 FIELD QUALITY CONTROL

- A. Survey-Work Benchmarks: Resurvey benchmarks regularly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

3.5 PROTECTION

- A. Protect and maintain dewatering system during dewatering operations.
- B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 312319

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SECTION 313116 - TERMITE CONTROL

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. Soil treatment.
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-place concrete" for sheet vapor retarder/termite barrier.
 - 2. Section 061000 "Rough Carpentry" for wood preservative treatment by pressure process.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components, and profiles for termite control products.
 - 2. Include the EPA-Registered Label for termiticide products.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Certificates: For each type of termite control product.
- C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and 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.

- D. Sample Warranties: For special warranties.

1.5 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.

1.6 FIELD CONDITIONS

- A. Soil Treatment:
 - 1. 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.
 - 2. Related Work: Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.7 WARRANTY

- A. 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: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain termite control products from single source from single manufacturer.

2.2 SOIL TREATMENT

- A. Termiticide: EPA-Registered termiticide acceptable to authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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- a. BASF Corporation, Agricultural Products; Termidor.
 - b. Bayer Environmental Science; Premise 75.
 - c. FMC Corporation, Agricultural Products Group; Talstar.
 - d. Syngenta; Demon TC.
2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than **five** years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label, 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.

3.2 PREPARATION

- A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.
- B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
 1. Fit filling hose connected to water source at the site with a backflow preventer, according to requirements of authorities having jurisdiction.

3.3 APPLYING SOIL TREATMENT

- A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.
 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.

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2. Foundations: Soil adjacent to and 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.
 3. Masonry: Treat voids.
 4. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.
- B. Post warning signs in areas of application.
- C. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 313116

SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes temporary excavation support and protection systems.

1.2 INFORMATIONAL SUBMITTALS

- A. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.
- B. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

1.3 FIELD CONDITIONS

- A. Interruption of Existing Utilities: Do not interrupt any utility-serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
 - 1. Notify Architect / Owner no fewer than two days in advance of proposed interruption of utility.
- B. Do not proceed with interruption of utility without Architect's / Owner's written permission
- C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Provide, design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.
 - 1. Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
 - 1. Shore, support, and protect utilities encountered.

3.2 INSTALLATION - GENERAL

- A. Locate excavation support and protection systems clear of permanent construction, so that construction and finishing of other work is not impeded.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation

3.3 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.
- B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.
- C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

- A. Drill, install, grout, and tension tiebacks.
- B. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.
 - 1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

- C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 BRACING

- A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
 - 1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
 - 2. Install internal bracing if required to prevent spreading or distortion of braced frames.
 - 3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 MAINTENANCE

- A. Monitor and maintain excavation support and protection system.
- B. Prevent surface water from entering excavations by grading, dikes, or other means.
- C. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

3.7 FIELD QUALITY CONTROL

- A. Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open.
 - 1. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions.
 - 2. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.
- B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.
- C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.8 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures.
 - 1. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.

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2. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.
3. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."
4. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION 315000

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Hot-mix asphalt paving.
- 2. Asphalt surface treatments.
- 3. Pavement-marking paint.

B. Related Sections:

- 1. Division 31 Section "Earth Moving for Sitework" for aggregate subbase and base courses and for aggregate pavement shoulders.
- 2. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

- 1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
 - a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
 - b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

- 1. Include technical data and tested physical and performance properties.
- 2. Job-Mix Designs: For each job mix proposed for the Work.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and testing agency.
- B. Material Certificates: For each paving material. Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.
- C. Material Test Reports: For each paving material, by a qualified testing agency.
- D. Field quality-control reports.

1.6 DEFINITION

- A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.7 QUALITY ASSURANCE

- A. Codes and Standards: Comply with Virginia Department of Transportation VDOT Standards and Specifications, Latest Edition and the City of Suffolk, Department of Public Works Standards Manual.
- B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
 - 1. Prime Coat: Minimum surface temperature of 60 deg F.
 - 2. Tack Coat: Minimum surface temperature of 60 deg F.
 - 3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
 - 4. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 - 5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 PAVEMENT MATERIALS

- A. General: Use locally available materials and gradations which exhibit a satisfactory record of previous installations.

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- B. Base Course Aggregate: Crushed stone, crushed gravel, crushed slag, and sharp-edged natural sand VDOT standard Type I Size 21A or 21B Aggregate.
- C. Base Course Aggregate: Crushed concrete having a gradation equivalent to VDOT standard Type I Size 21A or 21B stone.
- D. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material complying with AASHTO M 17 (ASTM D 242).
- E. Asphalt Cement: VDOT standard SM-9.5A surface mix, BM-25 base mix and as shown on plans.
- F. Tack Coat: VDOT standard RC-250, applied at 0.10 gal. per square yard of surface.
- G. All pavement message markings shall be VDOT approved Type B, Class VI markings. All other pavement markings shall be VDOT approved Type B, Class I Thermoplastic with and alkyd binder. All pavement markings shall be reflectorized.
- H. Reclaimed Asphalt Pavement (RAP) material may be used as a component material of asphalt mixtures in conformance with VDOT standards and the following:
 - 1. The final asphalt mixture shall conform to the requirements for the type specified.

2.2 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.
- B. Paving Geotextile: AASHTO M 288, nonwoven poly propylene; resistant to chemical attach, rot, and mildew; and specifically designed for paving applications.
- C. Pavement-Marking Paint: MPI #32 Alkyd Traffic Marking Paint.
 - 1. Color: as indicated.
- D. Wheel Stops: Precast, air-entranced concrete, 2500-psi minimum compressive strength, size as indicated on the plans. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
 - 1. Dowels: Galvanized steel, 1/2-inch diameter, 16-inch minimum length.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.

2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PATCHING

- A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
- B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseal concrete pieces firmly.
1. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.
- C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd..
1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- D. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.3 REPAIRS

- A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.
- B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.
1. Clean cracks and joints in existing hot-mix asphalt pavement.
 2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

- 3.4 Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess

3.5 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
 - 1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.
- C. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd.. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure.
 - 1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
 - 2. Protect primed substrate from damage until ready to receive paving.
- D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.6 PAVING GEOTEXTILE INSTALLATION

- A. Apply tack coat uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd..
- B. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches and transverse joints 6 inches.
 - 1. Protect paving geotextile from traffic and other damage and place hot-mix asphalt paving overlay the same day.

3.7 PLACING HOT-MIX ASPHALT

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
 2. Place hot-mix asphalt surface course in single lift.
 3. Spread mix at minimum temperature of 250 deg F.
 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.8 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
1. Clean contact surfaces and apply tack coat to joints.
 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.9 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
 2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.10 ASPHALT CURBS

- A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at a minimum temperature of 250 deg F.
 1. Asphalt Mix: Same as pavement surface-course mix.

- 3.11 Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.12 ASPHALT TRAFFIC-CALMING DEVICES

- A. Construct hot-mix asphalt speed **bumps, humps, cushions, and tables** over compacted pavement surfaces. Apply a tack coat unless pavement surface is still tacky and free from dust. Spread mix at a minimum temperature of 250 deg F.

1. Tack Coat Application: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..
2. Asphalt Mix: Same as pavement surface-course mix.
3. Before installation, mill pavement that will be in contact with bottom of traffic-calming device. Mill to a depth of 1 inch from top of pavement to a clean, rough profile.

- B. Place and compact hot-mix asphalt to cross section indicated, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.13 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch .
2. Surface Course: 1/8 inch .
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.14 PAVEMENT MARKING

- A. Cleaning: Sweep surface clean to remove all loose material and dirt.
- B. Do not apply traffic and lane marking paint until layout and placement has been verified with Architect/Engineer.

- C. Pavement markings shall be installed in accordance with the regulations governing the design, location, and operation of all official traffic signs, signals, and markings on and along highways within the Commonwealth of Virginia.
- D. The contractor shall prepare the pavement surface for the proper adhesion. Any sweeping or removal of debris, gravel, dirt, or other foreign materials shall be considered as incidental to the installation.
- E. The contractor shall remove completely all previous pavement markings which, in the opinion of the Architect/Engineer, conflict with the new pavement markings.
- F. Prior to application, the contractor shall field check and locate all pavement markings to the satisfaction and approval of the Architect/Engineer, and the City of Hampton, Civil Inspections Department if applicable.
- G. Thermoplastic pavement markings or preformed polymer shall not be installed at anytime within a 48-hour period following a rainfall.
- H. The color shall conform to the standard highway colors throughout the expected life of the film.
- I. Marking materials shall be applied at the specified dimensions and at the rate to result in a marking thickness of 90 mils +/- 5 mils (not including glass bead top dressing).
- J. The markings shall be provided in specified widths and shapes. The preformed words and symbols shall conform to the applicable shapes and sizes as outlined in the Manual on Uniform Traffic Control Devices for streets and highways, current edition or as modified.

3.15 WHEEL STOPS

- A. Install wheel stops as recommended by manufacturer.
- B. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.16 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
 2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
 - a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
 - E. Replace and compact hot-mix asphalt where core tests were taken.
 - F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.
- 3.17 DISPOSAL
- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Curbs and gutters.
- 2. Walks.

B. Related Sections:

- 1. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans.

1.4 PREINSTALLATION MEETINGS

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

- 1. Review methods and procedures related to concrete paving, including but not limited to, the following:
 - a. Concrete mixture design.
 - b. Quality control of concrete materials and concrete paving construction practices.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

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1.6 QUALITY ASSURANCE

- A. Codes and Standards: Comply with Virginia Department of Transportation VDOT Standards and Specifications, Latest Edition and the City of Suffolk, Department of Public Works Standards Manual.
- B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- D. ACI Publications: Comply with ACI 301 unless otherwise indicated.
- E. Preinstallation Conference: Conduct conference at Project site .

1.7 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
 - 1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from galvanized-steel wire into flat sheets.
- B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
- C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- D. Plain-Steel Wire: ASTM A 82/A 82M, galvanized.
- E. Deformed-Steel Wire: ASTM A 496/A 496M.

- F. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.
- G. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.
- H. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- I. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C 150, gray portland cement *Type II*. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class C or Class F.
 - 2. Blended Hydraulic Cement: ASTM C 595, Type IP, portland-pozzolan cement.
 - 3. Normal-Weight Aggregates: ASTM C 33, Class 4S , uniformly graded. Provide aggregates from a single source.
- B. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
 - 1. Aggregate Sizes: 3/8 to 5/8 inch nominal.
 - 2. Aggregate Source, Shape, and Color: .
- C. Water: Potable and complying with ASTM C 94/C 94M.
- D. Air-Entraining Admixture: ASTM C 260.
- E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
- F. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
 - 1. Color: As selected by Architect from manufacturer's full range .

2.4 FIBER REINFORCEMENT

- A. Synthetic Fiber: Monofilament or fibrillated polypropylene fibers engineered and designed for use in concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches long.

2.5 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
- F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.6 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.
- B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
 - 1. Types I and II, non-load bearing , for bonding hardened or freshly mixed concrete to hardened concrete.

2.7 STAMPED DETECTABLE WARNING MATERIALS

- A. Detectable Warning Stamp: Semirigid polyurethane mats with formed underside capable of imprinting detectable warning pattern on plastic concrete; perforated with a vent hole at each dome.

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- B. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation designed to facilitate release of stamp mats.

2.8 PAVEMENT MARKINGS

- A. Pavement-Marking Paint: MPI #97 Latex Traffic Marking Paint.
 - 1. Color: As indicated.

2.9 WHEEL STOPS

- A. Wheel Stops: Precast, air-entrained concrete.
 - 1. Dowels: Galvanized steel, 1/2 inch in diameter, 16-inch minimum length.

2.10 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:
 - 1. Compressive Strength (28 Days): 3000 psi .
 - 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
 - 3. Slump Limit: 5 inches , plus or minus 1 inch.
 - 4. Air Content: 5-1/2 percent plus or minus 1.5 percent .
- B. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
- C. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.5 lb/cu. yd. .
- D. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.11 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.5 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, to match jointing of existing adjacent concrete paving.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- H. Screed paving surface with a straightedge and strike off.
- I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
- K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
 - 1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.
- L. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 2. Do not use frozen materials or materials containing ice or snow.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- M. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
 2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
 3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 DETECTABLE WARNING INSTALLATION

- A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Section 321726 "Tactile Warning Surfacing."
1. Tolerance for Opening Size: Plus 1/4 inch, no minus.
- B. Cast-in-Place Detectable Warning Tiles: Form blockouts in concrete for installation of tiles specified in Section 321726 "Tactile Warning Surfacing." Screed surface of concrete where tiles are to be installed to elevation, so that edges of installed tiles will be flush with

surrounding concrete paving. Embed tiles in fresh concrete to comply with Section 321726 "Tactile Warning Surfacing" immediately after screeding concrete surface.

- C. Stamped Detectable Warnings: Install stamped detectable warnings as part of a continuous concrete paving placement and according to stamp-mat manufacturer's written instructions.
 - 1. Before using stamp mats, verify that the vent holes are unobstructed.
 - 2. Apply liquid release agent to the concrete surface and the stamp mat.
 - 3. Stamping: While initially finished concrete is plastic, After application and final floating of pigmented mineral dry-shake hardener, accurately align and place stamp mats in sequence. Uniformly load, gently vibrate, and press mats into concrete to produce imprint pattern on concrete surface. Load and tamp mats directly perpendicular to the stamp-mat surface to prevent distortion in shape of domes. Press and tamp until mortar begins to come through all of the vent holes. Gently remove stamp mats.
 - 4. Trimming: After **24** hours, cut off the tips of mortar formed by the vent holes.
 - 5. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

3.9 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or

tears occurring during installation or curing period using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.10 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/2 inch.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
6. Vertical Alignment of Dowels: 1/4 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.11 PAVEMENT MARKING

- A. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.
- B. Sweep and clean surface to eliminate loose material and dust.
- C. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.12 WHEEL STOPS

- A. Install wheel stops in bed of adhesive applied as recommended by manufacturer.
- B. Securely attach wheel stops to paving with not less than two galvanized steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- G. Concrete paving will be considered defective if it does not pass tests and inspections.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

- I. Prepare test and inspection reports.

3.14 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Cold-applied joint sealants.
- 2. Hot-applied joint sealants.

B. Related Sections:

- 1. Division 32 Section "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
- 2. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

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

B. Paving-Joint-Sealant Schedule: Include the following information:

- 1. Joint-sealant application, joint location, and designation.
- 2. Joint-sealant manufacturer and product name.
- 3. Joint-sealant formulation.
- 4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of joint sealant and accessory

1.6 QUALITY ASSURANCE

- A. Codes and Standards: Comply with Virginia Department of Transportation VDOT Standards and Specifications, Latest Edition and the City of Suffolk, Department of Public Works Standards Manual.
- B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- C. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.
- D. Product Testing: Test joint sealants using a qualified testing agency.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.7 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.
- B. Colors of Exposed Joint Sealants: as indicated by manufacturer's designations.

2.2 COLD-APPLIED JOINT SEALANTS

- A. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Crafcro Inc., an ERGON company; RoadSaver Silicone SL.
 - b. Dow Corning Corporation; 890-SL.
 - c. Pecora Corporation; 300 SL.
- B. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pecora Corporation; Urexpam NR-200.

2.3 HOT-APPLIED JOINT SEALANTS

- A. Hot-Applied, Single-Component Joint Sealant for Concrete and Asphalt: ASTM D 6690, Types I, II, and III.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Meadows, W. R., Inc.; [Sealtight Hi-Spec] [Sealtight 3405].
 - b. Right Pointe; D-3405 Hot Applied Sealant.

2.4 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

2.5 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of joint-sealant backings.
 - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
 - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place joint sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING

- A. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.6 PAVEMENT-JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Joints within cement concrete pavement.
 - 1. Joint Location:
 - a. Expansion and isolation joints in cast-in-place concrete pavement.
 - b. Contraction joints in cast-in-place concrete slabs.
 - c. Other joints as indicated.
 - 2. Silicone Joint Sealant for Concrete: Single component, nonsag or Single component, self-leveling.
 - 3. Joint-Sealant Color: Match Architect's sample.
- B. Joint-Sealant Application: Joints between cement concrete and asphalt pavement.
 - 1. Joint Location:
 - a. Joints between concrete and asphalt pavement.
 - b. Joints between concrete curbs and asphalt pavement.
 - c. Other joints as indicated.
 - 2. Hot-Applied Joint Sealant for Concrete and Asphalt: Single component.
 - 3. Joint-Sealant Color: Match Architect's sample.

END OF SECTION 321373

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SECTION 321400 - UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brick pavers.
2. Concrete pavers.
3. Curbs and edge restraints.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for concrete base under unit pavers and for cast-in-place concrete curbs and gutters serving as edge restraints for unit pavers.
2. Section 321443 "Porous Unit Paving" for unit paving using grid pavers or pavers with openings between them.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

A. Product Data:

1. For the following:
 - a. Pavers.
 - b. Bituminous setting materials.
 - c. Mortar and grout materials.
 - d. Edge restraints.
 - e. Precast concrete curbs.

- B. Sieve Analyses:** For aggregate setting-bed materials, according to ASTM C136.

- C. Samples for Verification:** For full-size units of each type of unit paver indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data:** For Installer.

- B. Material Certificates:** For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified unit paving installer. Installer's field supervisor must have Concrete Paver Installer Certification from the Interlocking Concrete Pavement Institute (ICPI) with one of the following designations:
 - 1. Residential Paver Technician Designation.
 - 2. Commercial Paver Technician Designation.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

1.7 FIELD CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- B. Weather Limitations for Mortar and Grout:
 - 1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 BRICK PAVERS

- A. Brick Pavers, Light-Traffic Paving Brick: ASTM C902, Class SX[or Class MX. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.
 - 1. Color: As selected by Architect from manufacturer's full range.

- B. Brick Pavers, Heavy Vehicular Paving Brick: ASTM C1272, Type F, Application PX, Type R, Application PS. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.
 - 1. Color: As selected by Architect from manufacturer's full range.
- C. Efflorescence: Brick to be rated "not effloresced" when tested according to ASTM C67.

2.3 CONCRETE PAVERS

- A. Concrete Pavers, Solid Interlocking Paving Units: Complying with ASTM C936/C936M and resistant to freezing and thawing when tested according to ASTM C67, made from normal-weight aggregates.
 - 1. Color: As selected by Architect from manufacturer's full range.

2.4 CURBS AND EDGE RESTRAINTS

- A. Steel Edge Restraints: Manufacturer's standard painted steel edging with loops pressed from or welded to face to receive stakes at 36 inches o.c. and steel stakes 15 inches long for each loop.
 - 1. Color: As selected by Architect from manufacturer's full range.
- B. Aluminum Edge Restraints: Manufacturer's standard extruded-aluminum edging with loops pressed from face to receive stakes at 12 inches o.c. and aluminum stakes 12 inches long for each loop.
- C. Job-Built Concrete Edge Restraints: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi.
- D. Precast Concrete Curbs: Made from normal-weight concrete with a compressive strength not less than 5000 psi and water absorption not more than 5 percent, in shapes and sizes indicated.
 - 1. Color and Texture: As selected by Architect from manufacturer's full range and texture.

2.5 AGGREGATE SETTING-BED MATERIALS

- A. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying with **ASTM D448** for Size No. 57 and/or requirements in Section 312000 "Earth Moving" for subbase material.
- B. Graded Aggregate for Base: Sound, crushed stone or gravel complying with requirements in Section 312000 "Earth Moving" for base course.
- C. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.
- D. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

- E. Drainage Geotextile: Nonwoven needle-punched geotextile fabric, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 PREPARATION

- A. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.
- B. Proof-roll prepared subgrade according to requirements in Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive [**subbase**] [**and**] [**base**] course for unit pavers.

3.3 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
 - 1. For concrete pavers, a block splitter may be used.
- D. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.
- E. Joint Pattern: As indicated by Architect
- F. Tolerances:
 - 1. Do not exceed 1/32-inch (0.8-mm) unit-to-unit offset from flush (lippage) from level, or indicated slope, for finished surface of paving.
 - 2.
- G. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
2. For metal edge restraints with top edge exposed, drive stakes at least **1 inch (25 mm)** below top edge.
3. Install job-built concrete edge restraints to comply with requirements in Section 033000 "Cast-in-Place Concrete."
4. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.

3.4 AGGREGATE SETTING-BED APPLICATIONS

- A. Compact soil subgrade uniformly to at least 95 percent of ASTM D698 laboratory density.
- B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Place separation geotextile over prepared subgrade, overlapping ends and edges at least 12 inches (300 mm).
- D. Place aggregate subbase and base, compact by tamping with plate vibrator, and screed to depth indicated.
- E. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches (300 mm).
- F. Place leveling course and screed to a thickness of 1 to 1-1/2 inches (25 to 38 mm), taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.
- G. Treat leveling course with herbicide to inhibit growth of grass and weeds.
- H. Set pavers with a minimum joint width of 1/16 inch (1.5 mm) and a maximum of 1/8 inch (3 mm), being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size unit pavers.
 1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.
 2. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches (900 mm) of uncompacted pavers adjacent to temporary edges.
 3. Before ending each day's work, compact installed concrete pavers except for 36-inch (900-mm) width of uncompacted pavers adjacent to temporary edges (laying faces).
 4. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches (90 mm) of laying face.

5. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
- I. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.
- J. Do not allow traffic on installed pavers until sand has been vibrated into joints.
- K. Repeat joint-filling process 30 days later.

3.5 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.
- C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.
 1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
 2. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

END OF SECTION 321400

SECTION 321713 - PARKING BUMPERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes wheel stops.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PARKING BUMPERS

- A. Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete, 4000-psi minimum compressive strength, 6 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, transverse drainage slots on underside, and a minimum of two factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.
 - 1. Mounting Hardware: Galvanized-steel spike or dowel, 1/2-inch diameter, 16-inch minimum length.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install wheel stops according to manufacturer's written instructions unless otherwise indicated.
- B. Securely anchor wheel stops to pavement with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer.

END OF SECTION 321713

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SECTION 321723 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes painted markings applied to asphalt and concrete pavement.
- B. Codes and Standards: Comply with Virginia Department of Transportation VDOT Standards and Specifications, Latest Edition and the City of Suffolk, Department of Public Works Standards Manual.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to marking pavement including, but not limited to, the following:
 - a. Pavement aging period before application of pavement markings.
 - b. Review requirements for protecting pavement markings, including restriction of traffic during installation period.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include technical data and tested physical and performance properties.
- B. Shop Drawings: For pavement markings.
 - 1. Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work.
 - 2. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the MUTCD of and VDOT for pavement-marking work.
 - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for alkyd materials and 55 deg F for water-based materials, and not exceeding 95 deg F .

PART 2 - PRODUCTS

2.1 PAVEMENT-MARKING PAINT

- A. Pavement-Marking Paint: MPI #32, alkyd traffic-marking paint or as required per Virginia Department of Transportation VDOT Standards and Specifications.
 - 1. Color: As indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that pavement is dry and in suitable condition to begin pavement marking according to manufacturer's written instructions.
- B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.2 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow paving to age for a minimum of 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
 - 1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils. Apply paint so that it cannot run beneath the stencil.

3.3 PROTECTING AND CLEANING

- A. Protect pavement markings from damage and wear during remainder of construction period.

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- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 321723

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SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes chain-link fences and swing gates.

1.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Chain-link fence and gate framework shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7:
 - 1. Minimum Post Size: Determine according to ASTM F 1043 for framework up to 12 feet high, and post spacing not to exceed 10 feet.

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. Fence and gate posts, rails, and fittings.
 - b. Chain-link fabric, reinforcements, and attachments.
 - c. Accessories: Privacy slats where indicated on drawings.
 - d. Gates and hardware.
 - e. Gate operators, including operating instructions and motor characteristics if applicable.
- B. Shop Drawings: For each type of fence and gate assembly.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include accessories, hardware, gate operation, and operational clearances.
 - 3. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
 - 4. Wiring Diagrams: For power, signal, and control wiring if applicable.

1.4 FIELD CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:
 - 1. Fabric Height: As indicated on Drawings.
 - 2. Steel Wire Fabric: Wire with a diameter of 0.148 inch (9-gage).
 - a. Mesh Size: 2 inches.
 - b. Polymer-Coated Fabric: ASTM F 668, Class 1 over galvanized zinc coated steel wire.
 - 1) Color: Black complying with ASTM F 934.
 - 3. Selvage: Knuckled at both selvages.

2.2 FENCE FRAMEWORK

- A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:
 - 1. Fence Height: As indicated on Drawings.
 - 2. Light Industrial Strength: Material Group IC-L, round steel pipe.
 - a. Line Post: 2.375 inches.
 - b. End, Corner and Pull Post: 3 inches.
 - c. Gate Post: 3 inches
 - 1) Leaf width over 10': 4 inches.
 - 3. Horizontal Framework Members: Top Rail: 1-5/8" in diameter complying with ASTM F 1043.
 - 4. Brace Rails: Comply with ASTM F 1043.
 - 5. Metallic Coating for Steel Framing:

- a. Type A zinc coating.
- 6. Polymer coating over metallic coating.
 - a. Color: Black complying with ASTM F 934.

2.3 TENSION WIRE

- A. Polymer-Coated Steel Wire: 0.177-inch diameter, bottom tension wire complying with ASTM F 1664, Class 1 over aluminum or zinc-coated steel wire.
 - 1. Color: Black complying with ASTM F 934.

2.4 SWING GATES

- A. General: Comply with ASTM F 900 for gate posts and single or double swing gate types.
 - 1. Gate Leaf Width: As indicated.
 - 2. Gate Fabric Height: As indicated.
- B. Pipe and Tubing:
 - 1. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing.
 - 2. Gate Posts: Round tubular steel.
 - 3. Gate Frames and Bracing: Round tubular steel.
- C. Frame Corner Construction: Welded or assembled with corner fittings.
- D. Hardware:
 - 1. Hinges: 180-degree inward or 180-degree outward swing.
 - 2. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
 - 3. Closer: Manufacturer's standard.

2.5 FITTINGS

- A. General: Comply with ASTM F 626.
- B. Finish:
 - 1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. zinc.
 - a. Black or green polymer coating over metallic coating.

2.6 PRIVACY SLATS

- A. Material: Polyethylene tubular slats, not less than 0.023 inch thick, manufactured for chain-link fences from virgin polyethylene containing UV inhibitor, sized to fit mesh specified for direction indicated; with vandal-resistant fasteners and lock strips.
- B. Color: As indicated on Drawings.

2.7 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

PART 3 - EXECUTION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for a certified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
 - 1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
 - 1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
- D. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.
- E. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacing's indicated, in firm, undisturbed soil.
- F. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
 - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.
- G. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.
- H. Line Posts: Space line posts uniformly at o.c.
- I. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Provide horizontal tension wire at the following locations:
 - 1. Extended along bottom of fence fabric unless otherwise indicated.
- J. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 1 inch between finish grade or surface and bottom selvage unless otherwise indicated.
- K. Privacy Slats: Install slats in direction indicated, securely locked in place.
- L. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.
- M. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

END OF SECTION 323113

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SECTION 329113 - SOIL PREPARATION.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes planting soils specified by composition of the mixes.
- B. Related Requirements:
 - 1. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
 - 2. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
 - 3. Section 329300 "Plants" for placing planting soil for plantings.

1.2 DEFINITIONS

- A. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- B. Imported Soil: Soil that is transported to Project site for use.
- C. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
- D. Planting Soil: Existing, on-site soil; imported soil; topsoil, or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- E. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- F. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- G. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- H. USCC: U.S. Composting Council.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

- A. Planting-Soil Type: Existing, on-site surface soil, with the duff layer, if any, retained and stockpiled on-site modified to produce viable planting soil. Blend existing, on-site surface soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
- B. Planting-Soil Type: Imported, naturally formed soil from off-site sources and consisting of loam soil according to USDA textures; and modified to produce viable planting soil.
 - 1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass.
 - 2. Additional Properties of Imported Soil before Amending: Soil reaction of pH 6 to 7 and minimum of 4 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
 - 3. Unacceptable Properties: Clean soil of the following:
 - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
 - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.
 - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 1 inch in any dimension.

4. Amended Soil Composition: Blend imported, unamended soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent.
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6(3.35-mm) sieve and a maximum of 10 percent passing through a No. 40 (0.425-mm) sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Perlite: Horticultural perlite, soil amendment grade.
- E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 (0.30-mm) sieve.
- F. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C33/C33M.

2.3 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance".

2.4 FERTILIZERS

- A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of [20] [33] [50] percent available phosphoric acid.
- B. 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:
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

PART 3 - EXECUTION

3.1 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.

- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

- A. Excavation: Excavate soil from designated area(s) to a depth of 4 inches (150 mm) and stockpile until amended.
- B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
- C. Unsuitable Materials: Clean soil to contain a maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.
- D. Screening: Pass unamended soil through a 3-inch (75-mm) sieve to remove large materials.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Spread unamended soil to total depth of 4 inches, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
 - 1. Amendments: Apply soil amendments, **except compost**, and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
 - a. Mix lime and sulfur if required with dry soil before mixing fertilizer.
 - b. Mix fertilizer with planting soil no more than seven days before planting.
 - 2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698 and tested in-place.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 BLENDING PLANTING SOIL IN PLACE

- A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Preparation: Till unamended, existing soil in planting areas to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.
 - 1. Mix lime and sulfur if required with dry soil before mixing fertilizer.
 - 2. Mix fertilizer with planting soil no more than seven days before planting.
- D. Compaction: Compact blended planting soil to **75 to 82** percent of maximum Standard Proctor density according to ASTM D698.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
 - 1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D698.
- C. Soil will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.6 PROTECTION AND CLEANING

- A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."
- B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
 - 1. Storage of construction materials, debris, or excavated material.

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2. Parking vehicles or equipment.
 3. Vehicle traffic.
 4. Erection of sheds or structures.
 5. Impoundment of water.
 6. Excavation or other digging unless otherwise indicated.
- C. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.
1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 329113

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Seeding.
- 2. Hydroseeding.
- 3. Sodding
- 4. Erosion-control materials.
- 5. Grass-paving materials.

B. Related Sections:

- 1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
- 2. Division 31 Section "Earth Moving for Sitework" for excavation, filling and backfilling, and rough grading.
- 3. Division 32 Section "Plants" for border edgings.

1.3 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

- F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

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

1.6 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 turfgrass 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.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.
- B. 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 Division 01 Section "Quality Requirements."
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. Personnel Certifications: Installer's personnel assigned to the Work shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Certified Landscape Technician - Exterior, with installation specialty area(s), designated CLT-Exterior.
 - b. Certified Turfgrass Professional, designated CTP.
 - c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.
 - 5. Pesticide Applicator: State licensed, commercial.

1.9 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 conformance 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" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying

1.10 PROJECT CONDITIONS

- A. Planting Restrictions: Plant during the following period. Coordinate planting period with initial maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Season 1: May 1 – September 15 (Bermuda)
 - 2. Season 2: September 15 – May 1 (Overseed with Annual Ryegrass)
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be

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obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.11 MAINTENANCE SERVICE

- A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:
 - 1. Seeded Turf: 90 days from date of Substantial Completion .
 - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
 - 2. Sodded Turf: 90 days from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species: State-certified seed of grass species as follows:
- C. Grass Seed Mix: Proprietary seed mix as follows:
 - 1. Products: Approved grass seed of a Bermuda grass shall be used. Bermuda variety of Vamont will be accepted. If seeding is preformed between September 15 and May 1, the contractor shall overseed with common annual ryegrass and at rate of 7 pounds per 1000 square feet. The contractor shall revisit the site after May 1 to ensure the permanent turf has been established. The contractor shall reseed areas that are unestablished as deemed necessary by landscape architect. The contractor shall fertilize with a weed and feed product at a rate of 3 pounds per 1000 square feet to control any weeds in the permanent turf if deemed necessary by landscape architect.

2.2 TURFGRASS SOD

- A. Turfgrass Sod: Certified Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Approved grass sod of a Bermuda grass shall be used. Bermuda variety of Vamont will be accepted. The sod shall be grown from approved seed of known origin

or from plantings or approved grass seedlings or stolons. It is to be inspected and certified to assure overall high quality and freedom from noxious weeds as well as excessive amounts of other crop and weedy plants at the time of harvest. The sod shall be machine cut in big roll form at a uniform soil thickness of one (1) inch at the time of cutting. Measurement for thickness shall exclude top growth and thatch. At least five (5) days before harvesting, the turf shall be mowed uniformly at a height of 1-1/2 inches. If sod is laid between May 1 and September 15, no over seeding is required. If sod is laid between September 15 and May 1, sod shall be a mixture of Vamont Bermuda grass and Annual ryegrass, sod shall be over seeded with common Annual Ryegrass at the rate of 7 pounds per 1000 square feet. The contractor shall visit the site after May 1 to ensure the permanent turf has been established. The contractor shall replace any unestablished areas as deemed necessary by the landscape architect. The contractor shall fertilize with a weed and feed product to control any weeds in the permanent turf as deemed necessary by the landscape architect.

2.3 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.

2.4 TOPSOIL

- A. Planting Soil: Imported topsoil or manufactured topsoil from off-site sources. Provide a minimum of 4 inches of topsoil, or manufactured topsoil from off-site sources, in all turf and grass areas. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.
 - 1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Classified loam material with not less than 4 percent organic material and with a pH between 6 and 7. Screened and free of stones 1 inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

2. Provide certificate of soil test analysis showing compliance to the specifications prior to spreading at the site. Obtain topsoil from local sources or from areas having similar soil characteristics to that found on the project site. Obtain topsoil only from naturally, well drained sites where topsoil occurs in a depth of not less than 4 inches. Do not obtain from bogs or marshes.
 - a. Existing Site Topsoil: Unless otherwise indicated, if testing shows existing topsoil conforms to the standards set forth for topsoil, to the satisfaction of the Architect/Engineer and Owner, then this topsoil may be used for seeded lawn planting purposes.

2.5 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

2.6 PESTICIDES

- A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.7 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples.
- B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples.
- C. Erosion-Control Mats: Cellular, nonbiodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface. Include manufacturer's recommended anchorage system for slope conditions.

2.8 GRASS-PAVING MATERIALS

- A. Grass Paving: Cellular, nonbiodegradable plastic mats, designed to contain small areas of soil and enhance the ability of turf to support vehicular and pedestrian traffic of

manufacturer's standard nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

- B. Base Course: Sound crushed stone or gravel complying with Section 312000 "Earth Moving" for base-course material.
- C. Sand: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.
- D. Proprietary Growing Mix: As submitted and acceptable to Architect.
- E. Sandy Loam Soil Mix: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate blended with planting soil
- F. Soil for Paving Fill: Planting soil.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 - 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.

- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

- A. Limit turf subgrade preparation to areas to be planted.
- B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- D. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. Prepare area as specified in "Turf Area Preparation" Article.
- B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.
- C. Fill cells of erosion-control mat with planting soil and compact before planting.
- D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 PREPARATION FOR GRASS-PAVING MATERIALS

- A. Reduce subgrade elevation soil to allow for thickness of grass-paving system. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade so that installed paving is within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions.
- B. Install base course and sand course and sandy loam soil mix or proprietary growing mix or soil for paving fill as recommended by paving-material manufacturer for site conditions and according to details indicated on Drawings. Compact according to paving-material manufacturer's written instructions.

- C. Install paving mat and fasten according to paving-material manufacturer's written instructions.
- D. Before planting, fill cells of paving mat with planting soil, sandy loam soil mix, or proprietary growing mix and compact according to manufacturer's written instructions.
- E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.6 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of 5 to 8 lb/1000 sq. ft.
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

3.7 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, commercial fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
 - 1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
 - 2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3.8 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 subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, 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 angle of slopes exceeding 1:3.

2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 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.

3.9 TURF RENOVATION

- A. Renovate existing turf where indicated.
- B. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
 1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
 2. Install new planting soil as required.
- C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.
- D. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
- E. Mow, dethatch, core aerate, and rake existing turf.
- F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
- H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.
- I. Apply soil amendments and initial fertilizer required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.
 1. Soil Amendments: according to requirements of Section 329113 "Soil Preparation.
 2. Initial Fertilizer: applied according to manufacturer's recommendations.
- J. Apply seed and protect with straw mulch as required for new turf.
- K. Water newly planted areas and keep moist until new turf is established.

3.10 TURF MAINTENANCE

- A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - 2. Water turf for no more than 1 year 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 1/3 of grass height. Remove no more than 1/3 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. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
 - 1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.11 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Landscape 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.

3.12 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with 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 Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.13 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. 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.
- C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 329200

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Plants.
- 2. Planting soils.
- 3. Fertilizers.
- 4. Mulches.
- 5. Herbicides & Pesticides.

B. Related Sections:

- 1. Division 01 Section "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
- 2. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
- 3. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
- 4. Division 32 Section "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

1.3 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- C. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- D. Finish Grade: Elevation of finished surface of planting soil.

- E. **Manufactured Topsoil:** Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- F. **Pesticide:** A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- G. **Pests:** Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- H. **Planting Area:** Areas to be planted.
- I. **Planting Soil:** Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- J. **Plant; Plants; Plant Material:** These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- K. **Root Flare:** Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- L. **Stem Girdling Roots:** Roots that encircle the stems (trunks) of trees below the soil surface.
- M. **Subgrade:** Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- N. **Subsoil:** All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- O. **Surface Soil:** Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. **Product certificates.**
- B. **Field quality-control reports.**

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Experience: Five years' experience in landscape installation in addition to requirements in Division 01 Section "Quality Requirements."
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Certified Landscape Technician - Exterior, with installation specialty area(s), designated CLT-Exterior.
 - b. Certified Landscape Technician - Interior, designated CLT-Interior.
 - c. Certified Ornamental Landscape Professional, designated COLP.
 - 5. Pesticide Applicator: State licensed, commercial.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
 - 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
 - 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
- D. Plant Material Observation: Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
 - 1. Notify Landscape Architect of sources of planting materials seven days in advance of delivery to site.
- E. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk fertilizers with appropriate certificates.
- C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- D. Handle planting stock by root ball.
- E. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
 - 1. Do not remove container-grown stock from containers before time of planting.
 - 2. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

1.8 PROJECT CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:
 - 1. Notify Landscape Architect no fewer than two days in advance of proposed interruption of each service or utility.
 - 2. Do not proceed with interruption of services or utilities without Architect's written permission.

- C. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Spring Planting: March 15 – May 15.
 - 2. Fall Planting: September 15 – November 15.
- D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.
- E. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
 - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.9 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.
 - b. Structural failures including plantings falling or blowing over.
 - c. Faulty performance of tree stabilization.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Periods from Date of Substantial Completion :
 - a. Trees, Shrubs: 12 months.
 - b. Ground Covers, Biennials, Perennials, and Ornamental Grasses: 6 months.
 - 3. Include the following remedial actions as a minimum:
 - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
 - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - c. Replacement of each plant will be required except for losses or replacements due to failure to comply with requirements for a period of one year from Substantial Completion.

1.10 MAINTENANCE SERVICE

- A. Initial Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below. Watering not to occur after 1 year.
 - 1. Maintenance Period: 12 months from date of Substantial Completion.
- B. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
 - 1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.
 - 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades or container sizes complying with ANSI Z60.1 for types and form of plants required.
- C. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

2.2 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or granular texture, with a pH range of 3.4 to 4.8.

2.3 FERTILIZERS

- A. Planting Tablets: Tightly compressed chip type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

2.4 PLANTING SOILS

- A. Planting Soil: All planting soil shall be a mixture of four parts topsoil, one part peat or composted organic matter, ½ part sand, with two cups of super absorbent polymer per cubic yard. The topsoil, peat (or composted organic matter) and sand shall be mixed at an approved on-site location or delivered premixed in bulk. Planting soil shall not be mixed at individual plan locations. Planting soil for deciduous plants shall have a pH value between 6.0 to 7.0. Planting soil for evergreen or semi-green plants shall have a pH value between 5.5 to 6.5. The pH value of the natural approved topsoil may be amended by adding limestone or aluminum sulfate as needed. Provide soil analysis certificate, showing compliance to Specifications prior to delivery. Super absorbent polymer shall be deleted from plant pits located in wet areas as determined by the Landscape Architect/Engineer.

2.5 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
1. Type: Shredded hardwood.
 2. Size Range: 3 inches maximum, 1/2 inch minimum.
 3. Color: Natural.

2.6 HERBICIDES & PESTICIDES

- A. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- B. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.
- C. Pesticides: Registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for

Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

2.7 TREE STABILIZATION MATERIALS

A. Stakes and Guys:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood , free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
2. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter.
3. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.

PART 3 - EXECUTION

3.1 EXAMINATION

- A.** Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.
1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B.** Proceed with installation only after unsatisfactory conditions have been corrected.
- C.** If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

3.2 PREPARATION

- A.** Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

3.3 PLANTING AREA ESTABLISHMENT

- A. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- B. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
 - 1. Excavate approximately three times as wide as ball diameter for container-grown stock.
 - 2. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
 - 3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
 - 4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 - 5. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 - 6. Maintain supervision of excavations during working hours.
 - 7. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
- B. Subsoil and topsoil removed from excavations may be used as planting soil if it meets the Planting Soils criteria.
- C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
- D. Drainage: Notify Landscape Architect if subsoil conditions show evidence of unexpected water seepage or retention in tree or shrub planting pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND PERENNIAL PLANTING

- A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-

most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

- B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Set container-grown and/or Balled and Burlapped stock plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
 - 1. Use planting soil for backfill.
 - 2. Carefully remove root ball from container without damaging root ball or plant.
 - 3. For Balled and Burlapped stock, place some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 - 4. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 - 5. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
 - 6. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 TREE AND SHRUB PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Prune, thin, and shape trees, shrubs, and vines as directed by Landscape Architect.
- C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Landscape Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- D. Do not apply pruning paint to wounds.

3.7 TREE STABILIZATION

- A. Install trunk stabilization as follows unless otherwise indicated:
 - 1. Upright Staking and Tying: Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Use a minimum of

- two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend to the dimension shown on Drawings above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
2. Use two stakes for trees up to 12 feet high and 2-1/2 inches or less in caliper; three stakes for trees less than 14 feet high and up to 4 inches in caliper. Space stakes equally around trees.
 3. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
 4. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

3.8 PLANTING IN PLANTERS

- A. Place a layer of drainage gravel at least 4 inches thick in bottom of planter. Cover bottom with filter fabric and wrap filter fabric 6 inches up on all sides. Duct tape along the entire top edge of the filter fabric, to secure the filter fabric against the sides during the soil-filling process.
- B. Fill planter with lightweight on-structure planting soil. Place soil in lightly compacted layers to an elevation of 1-1/2 inches below top of planter, allowing natural settlement.

3.9 GROUND COVER AND PERENNIAL PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.
- B. Use planting soil for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system but to a depth not less than two nodes.
- E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.10 PLANTING AREA MULCHING

- A. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees and Tree-like Shrubs in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 24-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.
2. Organic Mulch in Planting Areas: Apply 3-inch average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.11 INSTALLATION OF LANDSCAPE EDGINGS

- A. Shovel-Cut Edging: Separate mulched areas from turf areas, curbs, and paving with 45-degree, 4- to 6-inch- deep, shovel-cut edge.

3.12 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.
- B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.13 HERBICIDE & PESTICIDE APPLICATION

- A. Pre-Emergent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.
- B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.
- C. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.14 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

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- B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- C. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.15 DISPOSAL

- A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 329300

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SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Ductile-iron culvert pipe and fittings.
2. Ductile-iron, pressure pipe and fittings.
3. HP and PE pipe and fittings.
4. PVC pipe and fittings.
5. Fiberglass sewer pipe and fittings.
6. Concrete pipe and fittings.
7. Non-pressure transition couplings.
8. Pressure pipe couplings.
9. Expansion joints and deflection fittings.
10. Backwater valves.
11. Cleanouts.
12. Drains.
13. Encasement for piping.
14. Manholes.
15. Catch basins.
16. Stormwater inlets.
17. Stormwater detention structures.
18. Pipe outlets.
19. Stormwater disposal systems.

- B. Comply with The City of Suffolk, Department of Public Works, Standards Manual, Latest Edition, and the Virginia Department of Transportation (VDOT) Standards and Specifications, Latest Edition.

1.3 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. Catch basins, stormwater inlets, stormwater detention structures. Include plans, elevations, sections, details, frames, covers, and grates.
3. Stormwater Detention Structures: Include plans, elevations, sections, details, frames, covers, design calculations, and concrete design-mix reports.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
- C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

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

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes in accordance with manufacturer's written rigging instructions.
- D. Handle catch basins and stormwater inlets in accordance with manufacturer's written rigging instructions.

1.8 FIELD CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 1. Notify Owner no fewer than two days in advance of proposed interruption of service.
 2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON, CULVERT PIPE AND FITTINGS

- A. Pipe: ASTM A 716, for push-on joints.
- B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
- C. Compact Fittings: AWWA C153, for push-on joints.
- D. Gaskets: AWWA C111, rubber.

2.2 PE PIPE AND FITTINGS

- A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.
 - 1. Silt tight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
 - 2. Soil tight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.
- B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
 - 1. Silt tight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
 - 2. Soil tight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.3 PVC PIPE AND FITTINGS

- A. PVC Corrugated Sewer Piping:
 - 1. Pipe: ASTM F 949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
 - 2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
 - 3. Gaskets: ASTM F 477, elastomeric seals.

2.4 DUCTILE-IRON, CULVERT PIPE AND FITTINGS

- A. Pipe: ASTM A716, for push-on joints.
- B. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, for push-on joints.
- C. Compact Fittings: AWWA C153/A21.53, for push-on joints.
- D. Gaskets: AWWA C111/A21.11, rubber.

2.5 CONCRETE PIPE AND FITTINGS

- A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76.
 - 1. Bell-and-spigot or tongue-and-groove ends and gasketed joints with ASTM C 443, rubber gaskets
 - 2. Class II, Wall B.
 - 3. Class V, Wall C.

2.6 NONPRESSURE TRANSITION COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
 - 1. For Concrete Pipes: ASTM C 443, rubber.
 - 2. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 3. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 4. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Unshielded, Flexible Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dallas Specialty & Mfg. Co.
 - b. Fernco Inc.
 - c. Logan Clay Pipe.
 - d. Mission Rubber Company; a division of MCP Industries, Inc.
 - e. NDS Inc.
 - f. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
 - 2. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
- D. Shielded, Flexible Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cascade Waterworks Mfg.
 - b. Dallas Specialty & Mfg. Co.
 - c. Mission Rubber Company; a division of MCP Industries, Inc.

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2. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fernco Inc.
 - b. Logan Clay Pipe.
 - c. Mission Rubber Company; a division of MCP Industries, Inc.
2. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.7 EXPANSION JOINTS

A. Ductile-Iron Flexible Expansion Joints:

1. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.

2.8 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Top-Loading Classification(s): Heavy Duty.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. Plastic Cleanouts:

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.9 ENCASUREMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

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- B. Material: Linear low-density polyethylene film of 0.008-inch or high-density, cross-laminated polyethylene film of 0.004-inch] minimum thickness.
- C. Form: Sheet or tube.
- D. Color: Black.

2.10 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:
 - 1. Cement: ASTM C 150, Type II.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
 - 1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

2.11 MANHOLES

- A. Manholes shall be in accordance with The City of Hampton, Department of Public Works, Standards Manual, Latest Edition, and/or the Virginia Department of Transportation (VDOT) Standards and Specifications, Latest Edition.

2.12 CATCH BASINS

- A. Catch Basins and Drop Inlets shall be in accordance with The City of Hampton, Department of Public Works, Standards Manual, Latest Edition, and/or the Virginia Department of Transportation (VDOT) Standards and Specifications, Latest Edition.

2.13 STORMWATER INLETS

- A. Structures shall be in accordance with The City of Hampton, Department of Public Works, Standards Manual, Latest Edition, and/or the Virginia Department of Transportation (VDOT) Standards and Specifications, Latest Edition.

2.14 STORMWATER DISPOSAL SYSTEMS

- A. Chamber Systems:
 - 1. Source Limitations: Obtain chamber systems from single manufacturer.

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2. Storage and Leaching Chambers: Molded PE with perforated sides and open bottom. Include number of chambers, distribution piping, end plates, and other standard components as required for system total capacity.
 3. Filtering Material: ASTM D448, Size No. 24, 3/4- to 2-1/2-inch washed, crushed stone or gravel.
 4. Filter Mat: Geotextile woven or spun filter fabric, in one or more layers, for minimum total unit weight of 4 oz./sq. yd..
- B. Pipe Systems: Perforated manifold, header, and lateral piping complying with AASHTO M 252 for NPS 10 and smaller, AASHTO M 294 for NPS 12 to NPS 60. Include proprietary fittings, couplings, seals, and filter fabric.
- C. Source Limitations: Obtain pipe systems from single manufacturer

2.15 PIPE OUTLETS

- A. Flared End Section: shall be in accordance with The City of Hampton, Department of Public Works, Standards Manual, Latest Edition, and/or the Virginia Department of Transportation (VDOT) Standards and Specifications, Latest Edition.
- B. Riprap shall be placed where indicated on the plans. The minimum thickness of rip rap layer shall be two times the maximum stone diameter, but not less than 6 inches. Rip rap shall be Virginia Department of Transportation Class I with the following design values:

| D ₁₅ Weight (lbs) | Mean D ₁₅ Spherical Diameter (ft) | Mean D ₅₀ Spherical Diameter (ft) |
|------------------------------|---|---|
| 50 | 0.8 | 1.1 |
| Weight Range | Requirements for Stone Mixture | |
| 50 – 50 lbs | 60% > 100 lbs | |

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving for Sitework."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- D. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- E. Install gravity-flow, nonpressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow.
 - 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
 - 3. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:
 - 1. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
 - 2. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.5 STORMWATER INLET AND OUTLET INSTALLATION

- A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Construct riprap of broken stone, as indicated.
- C. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

3.6 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.7 STORMWATER DISPOSAL SYSTEM INSTALLATION

- A. Chamber Systems: Excavate trenches of width and depth, and install system and backfill in accordance with chamber manufacturer's written instructions. Include storage and leaching chambers, filtering material, and filter mat.
- B. Piping Systems: Excavate trenches of width and depth, and install piping system, filter fabric, and backfill, in accordance with piping manufacturer's written instructions.

3.8 IDENTIFICATION

- A. Materials and their installation are specified in Division 31 Section "Earth Moving for Sitework." Arrange for installation of detectable trace wire directly over piping and at outside edge of underground structures.
 - 1. Use detectable trace wire over ferrous piping.
 - 2. Use detectable trace wire over nonferrous piping and over edges of underground structures.

3.9 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.

2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
 - b. Option: Test concrete piping according to ASTM C 924.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

- A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION 334100