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IFB NO. Y17-718-CC

INVITATION FOR BIDS
FOR
DEPUTY JONATHAN "SCOTT" PINE COMMUNITY PARK

****

PART H
PARK SITE
TECHNICAL SPECIFICATIONS

VOLUME II
PART 2 OF 2

PROJECT MANUAL INCLUDING

SPECIFICATIONS FOR CONSTRUCTION OF:

JONATHAN "SCOTT" PINE COMMUNITY PARK

ORANGE COUNTY, FLORIDA

September 06, 2016

100% Submittal

PART 2 0F 2

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Division 22
Plumbing

SECTION 22 00 01 - PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Outside utilities 5'-0" beyond the building wall.

B. Final connections to heating, ventilating and air conditioning equipment.

C. Cutting and patching.

D. All concrete foundations or bases.

E. Mounting of all starters, except those specified to be factory-mounted and wired as part of the equipment. All wiring necessary to supply power to electric motors and remote operating valves, including connections from the disconnect switches and starters to the motors.

F. Providing the wiring of all plumbing alarm devices excluding house pump controls from the alarm devices to an alarm panel.

G. Motor disconnect switches and circuit breakers, except in combination starters and where otherwise noted.

H. All finished painting of exposed pipes and apparatus.

I. Domestic water meters and gas meters.

J. Installation of access doors in finished construction furnished as the work of this Section.

K. Flashing of pipes penetrating the roof.

L. Flashing of floor drains in membrane waterproofed floors.

M. Excavation and backfilling.

N. Bracing and supports for water heaters.

O. Toilet accessories.

1.3 WORK INCLUDED

A. Plumbing Fixtures and Trim.

B. Sanitary Waste and Vent Systems.

C. Water Supply System.

1.4 DESCRIPTION OF SYSTEMS

A. Provide all plumbing fixtures and trim as indicated on the drawings and as specified elsewhere herein. All fixtures shall be connected to the plumbing systems as indicated and required for proper operation. Piping materials, accessories, and equipment shall be as specified elsewhere in Division 22.

B. Sanitary Waste and Vent Systems:

1. Provide a complete sanitary, waste and vent system for all fixtures and equipment in the building requiring connections.
2. All waste from the building shall discharge by gravity from the building to 5 ft. outside of building as shown on the drawings.

C. Water Supply System:

1. Provide a complete water supply system for all fixtures and equipment in the building including domestic water heaters.
2. The Contractor for the work of this Section shall make all arrangements with the local officials and shall coordinate the meter, vault size and arrangement as directed by the local official.
3. The Contractor for the work of this Section shall furnish and install where shown on the drawings a domestic water meter as specified herein.
4. The domestic water system shall connect to 5’-0” outside of building as shown on the plans.
5. Local connections to fixtures and equipment shall be not less than full size of the fittings on the fixtures and equipment, and run-outs and risers serving same shall be as shown and not less than one pipe size larger than the fittings on the fixtures and equipment.
6. Provide stop-and-waste valves or ball valves at every branch off water mains where accessible and provide approved gate or compression stops at every connection to fixtures and equipment.
7. Provide water hammer arresters in accordance with the Plumbing and Drainage Institute Standard PDI-WH201. Provide access door at each location of shock arrester. All water hammer arresters shall comply with ANSI A112.26.1-1969 (R1975). Coordinate access door locations with the architect. Water hammer arresters shall not be located within walls.
8. Thermometers shall be provided, on the inlet and outlet of each water heater.

PART 2 - PRODUCTS

2.1 WATER HAMMER ARRESTERS

A. Water hammer arresters shall be lead free piston type and ANSI/ASSE 1010 2004 certified. Basis of design manufactured by J.R. Smith, Sioux Chief, and Watts**.** Provide access panels.

2.2 BACKFLOW PREVENTERS

A. 3/4" thru 2" reduced pressure zone backflow preventers shall be equal to Watts LF909 Series with 900AG air gap piped to drain.

PART 3 - EXECUTION

3.1 PIPING WORK - INSTALLATION

A. Piping in drawings may be shown offset for clarity of fixtures, equipment and routing intent for multiple piping systems that may be installed in close proximity in the field.

Contractor shall coordinate with all disciplines and provide offset as required to route pipe. Contractor shall coordinated clearance space with all equipment. The drawings shall be followed where they are definite and provided such procedure causes no objectionable conditions or does not conflict with other trades, laws, regulations or recommendations of equipment manufacturers. The drawings are intended to indicate the sizes of piping connections, and if certain sizes are omitted or unclear, obtain additional information before proceeding.

3.2 STERILIZATION OF PIPING AND EQUIPMENT

A. After all domestic cold water and hot water supply piping has been flushed free of foreign matter, and within 30 days prior to turning the building over to the Owner, this piping shall be sterilized in accordance with Section 22 11 17 – Disinfection of Domestic Water Lines.

3.3 OWNER TRAINING

A. Contractor shall provide training to Owner’s Maintenance department on all systems before to final completion certification can be issued. The Owner’s Maintenance department shall receive a second training period in the final month of the warranty period. Each training period shall be a minimum of eight (8) hours in length. Training shall include:

1. Classroom and field training.
2. Description of systems.
3. Start-up and shut-down procedures.
4. Operational and emergency procedures.
5. Maintenance procedures.
6. Spare parts and tools required.
7. Warranties and guarantees.

END OF SECTION 22 00 01

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SECTION 22 05 10 - BASIC MATERIALS AND METHODS FOR PLUMBING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Electrical requirements.

B. Painting.

C. Concrete work.

D. Fabricated steel supports.

E. Excavation, trenching and backfilling.

F. Placing of equipment.

1.3 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this Section to the extent referenced.

1. American Institute of Steel Construction (AISC) Publications
2. American National Standards Institute (ANSI) Standards
3. American Society for Testing and Materials (ASTM) Publications
4. American Welding Society (AWS) Publications
5. Underwriters Laboratories, Inc. (UL) Standards

1.4 SUBMITTALS

A. Where submittals are required, comply with Division 01.

B. Shop Drawings: Submit drawings of fabricated steel supports where proposed supports are not in accordance with details on drawings, or where drawings do not detail supports. Submittal for acceptance is required.

C. Product Data: Submittal for other than fabricated steel supports is not required. Product data for the following shall be included in the operation and maintenance manuals. Submittal for acceptance is not required.

PART 2 - PRODUCTS

2.1 FABRICATION

A. Electrical Requirements: Refer to Division 26 for requirements

B. Painting: Product specified in Division 09 - FINISHES.

C. Concrete Work:

1. Concrete is provided under DIVISION 03 - CONCRETE.

2. This contractor to provide detailed dimension drawings, including anchor bolt locations where required for all bases and pads required for equipment furnished under this Division.
3. Concrete for equipment bases and pads shall be 3000 p.s.i. design mix prepared in accord with ASTM C94. Cement shall be in accord with ASTM C150. Aggregate shall be fine sand in accord with ASTM C33. Water shall be clean, fresh, and drinkable.

D. Fabricated Steel Supports:

1. Steel angles, channels, and plate shall be in accordance with ASTM A36.
2. Steel members, including fasteners, exposed to weather shall be galvanized.

E. Excavation, Trenching, and Backfilling: Product description not applicable.

F. Placing of Equipment: Product description not applicable.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation of materials and equipment shall be in accordance with the manufacturer's written instructions, except as specified.

3.2 INSTALLATION

A. Electrical Requirements: All work as provided under Division 26.

B. Painting:

1. All equipment shall be furnished with a factory- applied galvanized, prime paint, or finish paint finish. Touch-up damaged surfaces of equipment immediately.
2. Paint for galvanized surfaces shall be in accordance with ASTM A780 using zinc rich compound.
3. Paint wooden mounting backboards with two coats of gray enamel prior to making attachments to the board.
4. For quality control refer to DIVISION 09 - FINISHES.
5. Remove all dirt, rust, scale, grease, pipe dope, solder flux, and welding slag from all surfaces to be painted.
6. Paint immediately, under this Division, all damaged galvanized surfaces. Paint galvanized metal surfaces behind grilles with two coats of flat black paint.
7. Apply rust inhibitive primer to ferrous surfaces of shop fabricated steel supports.
8. Paint immediately under this division all field and shop welded joints in piping or equipment supports with 2 coats of grey metal primer.

C. Concrete Work: All work as provided by Division 03.

D. Fabricated Steel Supports:

1. Because of the small scale of the drawings, details of equipment support are not always shown. It shall be the responsibility of the contractor to provide supports as required for safe and adequate support.
2. Fabricated steel supports and ladders may be shop or field-fabricated, and shall be in accord with details on drawings.
3. When details are not indicated, the contractor shall submit proposed support detail for review. The contractor shall bear all cost in producing this detail in the bid. This

includes but is not limited to structural engineering support.

4. Steel members shall be saw cut, with corners ground smooth, and shall be assembled with welded or bolted connections at Contractor's option. Connections shall be in accord with specified AISC Publications.

E. Excavation, Trenching, and Backfilling: Excavation, trenching, and backfilling for site utility piping systems specified in DIVISION 31.

F. Placing of Equipment:

1. Coordinate setting of equipment with the requirements of other trades so as to avoid conflicts and to insure compatibility. Equipment shall not block access for installation of other equipment.
2. Set base mounted equipment on permanent and finished supports. Temporary support, if any, shall be removed prior to making final pipe, duct, or electrical connections to equipment.
3. Adjust suspended equipment to final elevation prior to making pipe, duct or electrical connections.
4. Exercise caution during equipment placing operations to insure that structure is not overloaded.
5. Do not move heavy equipment across floor or roof of insufficient load bearing capacity to support such equipment. Provide bracing or shoring as required, or use crane to place equipment directly on permanent and finished support.
6. Secure all roof mounted equipment to the structure adequately to resist overturning, uplift and sliding forces for basic wind speeds indicated for this location in Figure 1609B of the Florida Building Code, 5th Edition (2014).

END OF SECTION 22 05 10

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SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Thermometers and Accessories.

B. Pressure Gauges and Accessories.

C. Pressure and Temperature Test Ports.

D. Pressure and Temperature Test Kit.

E. Install Miscellaneous Control Devices.

1.3 SUBMITTALS

A. Submit schedule of all products used. Include make, model and size. When multiple products will be used, generic size and flow range will be acceptable.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

C. Refer to Division 01 for submittal requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Thermometers and Accessories:

1. Duro Instrument Corp.
2. Taylor
3. H.O. Trerice
4. Weiss
5. Weksler
6. Winter’s ThermoGauges

B. Pressure Gauges and Accessories:

1. Ashcroft
2. Duro Instrument Corp.
3. H.O. Trerice
4. Weiss
5. Weksler
6. Winter’s Thermogauges

C. Pressure and Temperature Test Ports:

1. Peterson Equipment Co., Inc.

2. Sisco P/T Plugs
3. Approved Substitution

2.2 FABRICATION

A. Thermometers and Accessories:

1. Industrial Reading Non-Mercury Type:

a. Construction: Adjust angle, 9" scale with lagging extension brass well, of the blue dye (only) fill type and guaranteed accurate to ± one scale division. Thermometer shall have glass front to exclude dirt and dust. Thermometers containing mercury are not acceptable. Thermometers installed outdoors shall be specifically designed and weatherproofed for this application. Temperature range 30/300.

b. Stem Length:

(1)	6" pipe and smaller	3-1/2"
(2)	8" to 12" pipe	6"
(3)	For storage tanks	9"

c. Based on Weksler Type EG5H-9 or approved substitution.

2. Bi-Metal Dial Type:

a. Construction: 5" dial, adjust-angle, with lagging brass extension well. Stainless steel case bezel, fittings and stem. Head assembly sealed against dust, fumes and moisture with glass window. Accuracy of ± 1% of thermometer range and also be externally adjustable. Temperature range 30/300.

b. Stem Length:

(1)	6" pipe and under	2-1/2"
(2)	8" to 12" pipe	4-1/2"
(3)	For storage tanks	7-1/2"

c. Based on Weksler Type AF or approved substitution.

3. Thermometer Well: Construction - Brass or ductile iron body, with lagging extension, length to accommodate thermometer stem length. Based on Weksler or approved substitution.

B. Pressure Gauges and Accessories:

1. Pressure Gauges:

a. Construction: 4-1/2" dial, high impact polypropylene case, 1/4" bottom connection, 1/2% accuracy in accordance with ANSI B40.1 - 1974 Grade A. Stainless steel rotary with stainless steel pinion gear; stainless steel sector gear; stainless steel link. Stainless steel bourdon tube, 316 stainless steel socket and slotted adjustable pointer.

b. Case of black high impact polypropylene suitable for surface or direct mounting and with bottom connection. For outdoor locations, provide glycerin filled gauges.

c. Range: Ranges shall be so selected to indicate pressure reading in

midpoint of scale selected.

d. Based on Weksler Model AA44-2 and AY44-2 or approved substitution.

2. Manifold Valves (Trumpet Valve) (Water): - 2, 3 or 4 port - Brass body, spring return, push button brass valves, 1/4" compression connections. Gauge tap at top, calibrated gauge test port with gauge cock. 125 PSIG rated, 20°F to 220°F range. Based on Flow Conditioning Corporation Hydronic Indicator System or approved substitution.
3. Piston type snubber: Brass body, threaded connections, suitable for mounting horizontal or vertical. (Required at pump inlet and discharge.) Based on Weksler Type RS-1 or approved substitution.
4. Filter type snubber: Brass body, threaded connection, micro metallic stainless steel filter. (For all gauges except pump service). Based on Weksler Type BW42 or approved substitution.

C. Pressure and Temperature Test Ports:

1. Brass or stainless steel body with threaded cap and gasket, length to extend past insulation.
2. Two self closing valves with intermediate pocket for added pressure protection. Sized for standard 1/8" probe.
3. Range: 20°F to 230°F.
4. Rating: 250 PSIG water.
5. Based on Peterson Equipment Co., Inc. "Pete's Plug" Model 110 or 110XL or approved substitution.

D. Pressure and Temperature Test Kit:

1. Pressure-temperature test kits consisting of 0-100 PSIG pressure gauge with adapter, 25-125°F testing thermometer, 0-220°F testing thermometer, gauge adopted and protective carrying cast and master air vent assembly.
2. Provide 2 kits.
3. Based on Peterson Equipment Co., Inc., Series 1500 Test Kit or approved substitution.

PART 3 - EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturers written installation instructions.

3.2 INSTALLATION

A. Thermometers and Accessories:

1. Install and adjust thermometers for optimum visibility.
2. Provide thermometers where indicated on schematic flow diagram or schematic equipment details.
3. Install thermometers in compatible thermometer wells.

B. Pressure Gauges and Accessories:

1. Install and adjust gauge for optimum visibility.
2. Provide ball valve shut-off for all hydronic gauges.
3. Provide needle valve for all steam gauges.
4. Provide siphon for all steam gauges.

5. Provide a manifold valve to facilitate the use of a single gauge to monitor pressure differential from various points of a single piece of equipment (i.e. pump; strainer suction; pump suction; pump discharge, etc.). Mount valve for optimum visibility and access.
6. In lieu of the trumpet valve the contractor may assemble individual components using ball valves as the isolation valve provided the same functions of the trumpet valve are duplicated.
7. Provide piston type snubbers for pump service.
8. Provide filter type snubbers for all other fluid services.
9. Open shut-off valve only enough to obtain accurate reading. Valve to gauge to be closed at all other times.

C. Pressure and Temperature Test Ports:

1. Install in upright or vertical position upstream and downstream of every strainer.
2. Install in tee or welded outlet.

D. Pressure and Temperature Test Kit: Turn complete kits in good working condition over to Owner, when the Owner takes over the building.

E. Install miscellaneous control devices such as thermometer wells, tees for flow measuring stations, connections for differential pressure sensors, etc.

END OF SECTION 22 05 19

SECTION 22 05 23 – GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Ball valves.

B. Check valves.

C. Drain valve.

1.3 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this Section to the extent referenced. The publications are referenced to in the text by the basic designation only.

1. American National Standards Institute (ANSI).
2. American Society for Testing and Materials (ASTM).

1.4 SUBMITTALS

A. Submit schedule and cut-sheets indicating service, make and model number, pressure class, end type and usage (i.e., balance, shut-off).

B. Product data shall be included in the operation for maintenance instruction manuals along with installation, operation and maintenance instructions.

C. Refer to Division 01 for Submittal requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Ball Valves:

1. Apollo
2. Crane Company
3. Milwaukee Valve.
4. Nibco, Inc.
5. Stockham

B. Check Valves:

1. API International, Inc.
2. Milwaukee Valve
3. Nibco, Inc.
4. Stockham

C. Drain Valves:

1. Apollo.
2. Nibco, Inc.
3. Watts

2.2 FABRICATION

A. Ball Valves:

1. Potable water service:

a. Size 1/4" thru 2". Brass body, threaded or sweat connection, bronze, stainless steel or bronze full port ball, teflon or silicone bronze seat, steel lever handle, indicator stop, 150 lb. 600 WOG. Based on Nibco T-585-80-LF, S-585-80-LF
b. Size ½” thru 2”. Two piece, standard port type with brass body, Vic Press 304™ connection, brass ball and stem, Teflon seat, carbon steel handle, 300 CWP.
c. Valves installed in insulated piping to have extended handles to clear insulation. Stem extension shall be made of a non-thermal conducting material with a sleeve to form an insulated vapor seal after the valve is insulated.

B. Check Valves:

1. Potable Water Service:

a. Horizontal swing check valve:

(1) Size 1/2" thru 2". Bronze body thread or sweat connection, "Y" pattern, bronze seat, renewable teflon or bronze swing disc, Class 125. Based on Nibco T-413-Y-LF or S-413-Y-LF or approved substitution.
(2) Size 2-1/2" and up. Bronze body, bolted cover, bronze seat, bronze disc holder. Renewable bronze disc, Class 125. Based on Nibco F-910 or approved substitution.

b. Vertical lift check valve.

(1) Size 1/2" thru 2-1/2". Bronze body, threaded or sweat connection, renewable teflon disc and seat, copper or stainless steel, spring loaded, stainless steel guide pin Class 125. Based on Nibco T-480-Y-LF or S-480-Y-LF or approved substitution.

c. Spring check valve:

(1) Size 1/2" thru 2". Bronze body thread or sweat connection, "Y" pattern, lead free, inline lift type, spring actuated, resilient discs. Temperature rating 300^{o}. Based on Nibco T-480-Y-LF or S-480-Y-LF or approved substitution.

C. Drain valves:

1. Potable water service:

a. Size 1/2" and 3/4". Two piece, adapter loaded, single reduced port type with brass body, iron pipe thread inlet or sweat inlet, 3/4" hose thread

outlet, brass cap and chain at outlet, stainless steel stem, stainless steel ball, teflon or silicone bronze seat, steel lever handle, indicator stop, 150 lb. 600 WOG.

b. Size ½” thru 2”. Two piece, standard port type with brass body, brass ball and stem, Teflon seat, carbon steel handle, 300 CWP.

c. Valves installed in insulated piping to have extended handles to clear insulation. Based on Watts B-6000-CC or B-6001-CC or Nibco T-585-70HC or approved substitution.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide shut-off valves on the inlet and outlet of each piece of equipment and meter at the take-off of each major branch from a header and at the base of each pipe riser in order to facilitate service.

B. Provide drain valves at the base of each pipe riser and at each piece of equipment to facilitate service.

C. Provide locking device on handle of the expansion tank isolation valve to prevent accidental closing.

D. All valves shall be UL classified in accordance with ANSI / NSF-61 for potable water service, and shall meet the low lead requirements of NSF-372.

3.2 INSTALLATION

A. Ball Valves:

1. Install valves with adequate access to lever actuator.
2. Provide adequate space for actuator handle in the open and closed position and for packing replacement.
3. Provide infinite position handle with memory stop on the outlet of all heat exchangers for balancing purposes.

B. Check Valves:

1. Horizontal swing check valves: Install valve with swing disc in the pendent position, cover in upright position.
2. Vertical lift check valve:

a. Install valve in vertical position, upward flow.
b. Flanged valves will be installed between 125# or 150 ANSI flanges or other flanged valves.
c. A spool piece a minimum of 6" face to face will be used to separate a vertical lift check valve and a butterfly valve.
d. Inspect the face of the flange and valve for casting/matching burrs. If burrs exist remove by draw filling prior to gasket placement.

C. Drain Valves: Install valves to provide adequate space for hand wheel, access, stem travel, disc replacement cap removal and clearance for easy hose connection without crimping hose.

END OF SECTION 22 05 23

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SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Inserts, Shells and Upper Attachments.

B. Pipe Hangers, Rods, Supports and Accessories.

C. Pipe Sleeves.

D. Pipe Seals.

E. Fabricated Steel Support.

1.3 QUALITY ASSURANCE

A. Design of pipe supporting elements shall be in accordance with ANSI B31.1.

B. Fabrication and installation of pipe hangers and supports shall be in accordance with the following Manufacturers Standardization Society (MSS) Standards.

1. SP-58 Pipe Hangers and Supports: Materials, Design and Manufacture.
2. SP-69 Pipe Hangers and Supports: Selection and Application.
3. SP-89 Pipe Hangers and Supports: Fabrication and Installation Practices.

C. Steel angles, channels and plate shall be in accordance with ASTM A36, red primed or hot dipped galvanized for interior applications, and hot galvanized for exterior applications.

D. Bolts, including nuts and washers, used for fabricating steel members shall be in accordance with ASTM A325 and shall be stainless steel or plated for corrosion protection. Plain steel components are unacceptable.

E. Welding of steel members shall be in accordance with AWS D1.1.

F. Steel supports for pipe anchors, pipe guides, and piping supported from below shall be fabricated in accordance with AISC Specification for the Design, Fabrication and Erection of Structural Steel for buildings. If required, the contractor shall include the cost of the services of a structural engineer to design or review the system.

1.4 APPLICABLE PUBLICATIONS

A. Applicable sections of the publications listed below form a part of this Section. The publications are referenced to in the text by the basic designation only.

1. American Institute of Steel Construction (AISC)
2. American National Standards Institute (ANSI)
3. American Society for Testing and Materials (ASTM)
4. American Welding Society (AWS)

5. The Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS)
6. National Fire Protection Association (NFPA)
7. Sheet Metal and Air Conditioning Contractor's National Association, Inc. (SMACNA)

1.5 SUBMITTALS

A. Submit schedule indicating type of hanger to be used by system and pipe size. Include rod size for each hanger size.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

C. Refer to Division 01 for submittal requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Inserts, Shells and Upper Attachments:

1. Anvil International, Inc.
2. Carpenter Paterson, Inc.
3. Cooper B-Line®, Inc.
4. Elcen Metal Products
5. Hilti
6. Michigan Hanger Company
7. PHD Manufacturing, Inc.
8. Unistrut®

B. Pipe Hangers, Rods, Supports and Accessories:

1. Anvil International, Inc.
2. Carpenter Paterson, Inc.
3. Cooper B-Line®, Inc.
4. Elcen Metal Products
5. Hilti
6. Michigan Hanger Company
7. PHD Manufacturing, Inc.
8. Unistrut®

C. Pipe Sleeves:

1. Metraflex – Metraseal
2. Thunderline Corporation - Link Seal
3. Owner approved substitution.

D. Pipe Seals:

1. Metraflex – Metraseal
2. Thunderline Corporation - Link Seal
3. Owner approved substitution.

E. Fabricated Steel Support: As Detailed on Drawings.

2.2 FABRICATION

A. Inserts, Shells and Upper Attachments:

1. Inserts; MSS Type 18; malleable iron body and nut, galvanized finish, opening in top of insert for reinforcing rod, lateral adjustable. Rated for 1,140 lbs. Based on Anvil Fig. 282 or approved substitution.
2. Shells: Steel shell and expander plug, snap off end fastener. Based on Phillips Concrete Fasteners Red Head or approved substitution.
3. Upper Attachments:

a. Top beam clamps; MSS Type 19: Malleable iron galvanized finish clamp, hardened steel cup point set screw and locknut. Rating is contingent on rod and bolt size. Based on Anvil Fig. 94 or approved substitution.
b. Bottom Beam Clamp; MSS Type 23: Malleable iron galvanized finish clamp, hardened steel cup point set screw and locknut, and retaining clip. Rating is contingent on rod and bolt size. Based on Anvil Fig. 86 Clamp and Fig. 89 Retaining Clip (or Fig. 87) or approved substitution.
c. Welded Beam Attachment; MSS Type 22: Carbon steel suitable for eye rod or rod and locknut, rating is contingent on rod and bolt size. Based on Anvil Fig. 66 or approved substitution.
d. Center Beam Clamp; MSS Type 21: Malleable iron jaw and square head bolt and nut with galvanized finish. Rating is contingent on rod and bolt size. Based on Anvil Fig. 134 or approved substitution.
e. Center Beam clamp; MSS Type 29: Forged steel, weldless eye nut, tie rod to secure clamp to beam all with galvanized finish, rating is contingent on rod and bolt size. Based on Anvil Fig. 292 or 292L or approved substitution.

B. Pipe Hangers, Rods, Supports and Accessories:

1. Pipe Hangers:

a. Clevis Hanger; MSS Type 1: Carbon steel, galvanized for interior and exterior use, sized to accommodate required insulation. Rating is contingent on rod and bolt size. Based on Anvil Fig. 260 or 300 or approved substitution.
b. Pipe Rings; MSS Type 10: Carbon steel, galvanized for black steel and insulated pipe copper or copper plated or rubber coated for copper pipe. Threaded swivel, sized to accommodate required insulation. Rating is contingent on rod and bolt size. Based on Anvil Fig. 69 or Fig. 97C for copper pipe or approved substitution.
c. Adjustable Roller Hanger; MSS Type 43: Cast iron roll, carbon steel yoke rod roll and hex nut with galvanized finish. Sized to accommodate insulation. Rating is contingent on rod and bolt size. Based on Anvil Fig. 181 or approved substitution.

2. Rods:

a. Size 3/8" and up: All thread steel rod electro galvanized. Sizing for pipe or equipment support as follows:

Copper Tube, Plastic Fiberglass Reinforced Pipe Size	Steel, Cast Iron or Glass Pipe Size	Rod Size	Max Equip. Load
¼” to 2”	¼” to 2”	3/8”	730 lbs.

2-1/2” to 5”	2-1/2” to 3”	½”	1350 lbs.
6”	4” to 5”	5/8”	2160 lbs
8” to 12”	6”	¾”	3230 lbs.
14”	8” to 12”	7/8”	4480 lbs.
16”	14” to 16”	1”	5900 lbs.
18” to 20”	18” to 20”	1-1/4”	9500 lbs.
22” to 42”	22” to 42”	1-1/2”	13,800 lbs.

b. Rods may be reduced one size for double rod hangers with 3/8” minimum diameter, or when other paragraphs require a minimum of 2 hangers per section provided the minimum diameter of 3/8” in maintained. Based on Anvil Fig. 146 or approved substitution.

3. Supports:

a. Pipe Saddle; MSS Type 38: Cast iron saddle, black steel lock nut nipple, cast iron reducer all with galvanized finish. Suitable for standard field cut and threaded galvanized steel pipe. Cast iron floor flange. Based on Anvil Fig. 264 Saddle, Fig. 63 Floor Flange or approved substitution.

b. Pipe Saddle Cold Piping: MSS Type 40. Single bonded unit consisting of a galvanized metal shield and a molded section of rigid polyurethane foam insulation. Rigid urethane foam shall have a density of 4 pounds per cubic foot, a thermal conductivity of 0.13 Btu.in/sq.ft./hr.^{o}F at 75^{o}F mean temperature. Insulation thickness to be equal to thickness specified for pipe being supported.

c. Adjustable Pipe Roll and Base; MSS Type 46: Cast iron base plate steel stand and roll, adjusting screws with galvanized finish. Based on Anvil Fig. 274 or approved substitution.

d. Welded Steel Bracket; MSS Type 32: Welded carbon steel rate for 1500 lbs., with galvanized finish. Rating is contingent on rod and bolt size. Based on Anvil Fig. 195 or approved substitution.

e. Riser Clamps; MSS Type 8: Carbon steel, galvanized finish for black steel or galvanized pipe, plastic coated for cold steel, copper, glass or brass pipe rated for a minimum of 220 lbs. at 3/4" size. Based on Anvil Fig. 261 or approved substitution.

4. Accessories:

a. Protective Shields; MSS Type 40: Carbon steel, galvanized minimum of 12" length sized for required insulation. Based on Anvil Fig. 167 or approved substitution.

b. Protective Saddles; MSS Type 39: Carbon steel plate, minimum of 12" length, sized for required insulation. Based on Anvil Fig. 160 thru 165.

c. Steel Turnbuckle; MSS Type 13: Forged steel, galvanized finish with locknuts. Rated at a minimum of 730 lbs. at 3/8" size. Based on Anvil Fig. 230 or approved substitution.

d. Steel Clevis; MSS Type 14: Forged steel, galvanized finish with steel pin and cotter pin. Rated for a minimum of 730 lbs. at 3/8" size. Based on Anvil Fig. 299 or approved substitution.

e. Weldless Eye Nut; MSS Type 17: Forged steel, galvanized finish. Rated for a minimum of 730 lbs. at 3/8" size. Based on Anvil Fig. 290 or 290L or approved substitution.

C. Pipe Sleeves:

1. Wall: Schedule 40 carbon steel pipe sized to accommodate pipe. If sleeves are

field cut, coat cut edges with cold galvanizing spray, ZRC or approved substitution.

2. Floor Slab or Exterior Stem Walls below Grade:

   a. Copper domestic water pipe use 6 mil poly red and blue sleeving. Use two tie wraps as the clamp, wrap twice around the pipe.
   b. PVC cast it in the slab.
   c. Cast iron cast it in the slab

3. Sized to accommodate pipe. Sleeve length will be sized to allow a minimum of 1/2" extension below floor or exterior side of a wall below grade and 1-1/2" extension above floor and 1/2" extension on interior side of an exterior wall below grade.
4. Roof: All penetrations of roof to be in accordance with requirements of Division 07 - Thermal and Moisture Protection.
5. Based on Thunderline Corp. Link Seal Wall Sleeve or approved substitution.

D. Pipe Seals: Composition Plastic Pressure Plates, zinc coated bolts, nuts and metal parts, composition rubber sealing element designed for long term stability rated for temperatures of 40°F to +250°F. Based on Thunderline Corp. Link Seal LS Series or approved substitution.

E. Fabricated Steel Supports:

1. Field or shop fabricated. See details on drawings.
2. If not detailed on drawings the contractor is to provide suitable supports as required.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Where applicable install in accordance with the manufacturers written installation instructions.

B. Where supports are in contact with copper pipe provide copper plated support, or wrap pipe with sheet lead.

C. Where supports are in contact with glass, aluminum or brass pipe provide plastic coating on supports, or wrap pipe with sheet plastic.

D. General interior supports, including attachments and pipe supports that are plain steel shall be cleaned of all rust, primed and painted black within one week of installation. At substantial completion all supports shall be free of rust and in a “like new condition”.

E. Hangers and supports, including attachments & pipe supports, exposed to weather or located in utility tunnels or accessible utility trenches or subject to spillage shall be hot dip galvanized after fabrication. At substantial completion all supports shall be free of rust and in a “like new condition”.

F. Fabricated steel supports exposed to weather (including pipe supports) or located in utility tunnels and accessible utility trenches or subject to spillage shall be hot dipped galvanized after fabrication, primed and painted black within one week of installation. Cut, welded, drilled, or otherwise damaged surfaces of galvanized coating shall be repaired. At substantial completion all supports shall be free of rust and in a “like new condition”.

3.2 INSTALLATION

A. Inserts, Shells and Upper Attachments:

1. Inserts:

a. Contractor shall have inserts at site and dimensioned location drawings ready at the beginning of the involved concrete work.
b. Install inserts by securing to concrete forms and inserting reinforcing rod thru the opening provided in the insert in accordance with shop drawings.
c. Provide necessary supervision while concrete is being poured to correct any misalignment caused by the concrete.

2. Shells: Size shell length to assure a minimum of 1" solid concrete remaining from shell end to concrete face.
3. Upper Attachment:

a. Select proper attachment for building construction.
b. For plain steel devices, prime with black paint prior to installation.
c. Adjust attachment location for proper alignment and no more than 4 deg. offset from a perpendicular alignment.
d. If proper alignment cannot be achieved from the existing building structure provide a trapeze type support size to handle the design load with a minimum safety factor of 5.

B. Pipe Hanger, Rods, Supports and Accessories:

1. Select proper hanger for piping systems.
2. The location of hangers and supports shall be coordinated with the structural work to ensure that the structural members will support the intended load.
3. Provide hex head nut on rod at top and bottom of clevis hanger yoke, and at each rod connection to intermediate and upper attachment. Rod nuts shall be securely locked in place.
4. Hanger rods shall be subject to tensile loading only. Where lateral or axial movement is anticipated, use suitable linkage in hanger rod to permit swing.
5. Hangers shall be fabricated to permit adequate adjustment after erection while still supporting the load. Turnbuckles shall be provided where required for vertical adjustment of the piping.
6. Supports for vertical piping shall be located at each floor or at intervals of not more than 15 feet and at intervals of not more than 8 feet from end of risers. Where supports are provided on intermediate floors spaced 15 feet or less between floors, no additional supports are required other than those specified for end of risers.
7. A hanger or support shall be provided adjacent to each piece of equipment to ensure that none of the pipe weight is supported from the equipment.
8. The maximum spacing between pipe supports for straight runs shall be in accordance with the following chart. If any deviation from the table exists within the manufacturers written installation instructions, whichever spacing reflecting the smaller centerline to centerline dimension shall be used.

MAXIMUM HORIZONTAL AND VERTICAL PIPE HANGER AND SUPPORT SPACING TABLE

a. Steel Pipe (Schedule 40 & 80):

Up to 1": Horizontal 7 ft. on center/Vertical 10 ft.
1-1/4" and greater: Horizontal 10 ft. on center/Vertical 10 ft.

b. Copper Pipe (Type L):

Up to 1" size: Horizontal 5 ft. on center/Vertical 10 ft.
1-1/4" and larger: Horizontal 6 ft. on center/Vertical 10 ft.

c. Ductile Iron and Cast Iron: Two hangers per section length.
d. Polyvinyl Chloride (PVC):
Up to 1-1/2": Horizontal 3 ft. on center/Vertical 10 ft.
2" and larger: Horizontal 4 ft. on center/Vertical 10 ft.

e. Chlorinated Polyvinyl Chloride (CPVC):
Up to 1": Horizontal 3 ft. on center/Vertical 10 ft.
1-1/4" and larger: Horizontal 4 ft. on center/Vertical 10 ft.
Provide mid-story guide for sizes 2 inches and smaller.

9. Hanger centerline spacing shall be reduced by 50% in areas of concentrated valves and/or fittings, also no more than a maximum distance of 12 inches from valves, fittings and/or couplings, or 24 inches from a change in direction.
10. Parallel piping may be supported by trapeze hangers consisting of steel angle, channel, or beam suspended by steel rods attached to upper structure. Piping may be supported above, or suspended below, the angle, channel, or beam.
11. Provide protective shields on all cold and dual temperature piping required to be insulated.
12. Provide protective saddles sized to match insulation thickness on all hot piping required to be insulated. Fill void between saddle and pipe with insulation as specified.
13. Provide turnbuckles on all hangers which require leveling or aligning.
14. Provide steel clevis where detailed and/or required.
15. Provide weldless eye nuts on hanger terminations where disassembly or swing may be required. Use in combination with steel clevis.

C. Additional CPVC Pipe Hanger and Supports Requirements:

1. Vertical piping must be supported properly at intervals that will prevent excessive loading on the fitting at the lower end of the riser.
2. Hangers and clamps suitable for this purpose include riser clamps or double bolt type clamps installed in such a manner that will allow for movement of the pipe due to thermal expansion and contraction (i.e. floating system).
3. Clamps and hangers used must not compress, distort, cut, or abrade the piping. Clamps used must not exert compressive stresses on the pipe; the use of riser clamps that utilize compression to support the pipe weight shall not be used.
4. Riser clamps should be located just below a fitting so that the shoulder of the fitting rests against the clamp to support the weight of the vertical column.
5. Provide modified coupling to provide vertical support where required. Coupling shall be cut above the seat and then cut length wise to form a clamp shell. Solvent cement coupling halves on to pipe at proper location for modified couple to rest on support clamp. Clamp shall not compress on pipe.
6. Vertical riser shall be routed straight in alignment.
7. Horizontal take- offs from the riser should be independently supported, and located as close to the riser clamp as possible.
8. Provide offset between riser tee and wall entry to minimize stress on the horizontal connection.
9. Provide expansion loops in horizontal runs to allow for pipe expansion.

D. Pipe Sleeves:

1. Secure sleeves to forms for concrete construction. Ensure sleeves are not disengaged or misaligned by concrete placement operations.
2. Provide temporary cap for open end of sleeves to prevent entrance of concrete.
3. Provide temporary internal bracing where required preventing distortion of sheet metal sleeves by concrete placement operations.
4. Sleeves shall not be installed in structural members, except where indicated or approved.
5. Furnish sleeves to masonry contractor in advance of masonry work. Furnish dimensioned drawings indicating exact location of sleeves.
6. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface, except as indicated otherwise.
7. Sleeves passing through floors in wet areas, such as areas containing plumbing fixtures or floor drains, shall extend a minimum of 4 inches above the finished floor. Sleeves in wet areas shall be enclosed with 4 inch concrete curb.
8. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/4 inch clearance all around between the pipe and inside of sleeve, or between jacket over insulation and sleeve.
9. Provide membrane clamping devices on sleeves for waterproof floors.
10. Sleeves are not required in existing structures where openings through existing concrete floors, walls, or roof are core drilled.

E. Pipe Seals:

1. Provide pipe seals for all pipe sleeves used in:
   a. External walls.
   b. Floor slabs on grade.
   c. Upper floors where spillage may occur.

F. Fabricated Steel Supports: Steel for supports shall be saw cut, with sharp edges ground smooth. After fabrication remove all foreign material, including welding slag and spatter, and leave ready for painting or galvanizing, as applicable.

END OF SECTION 22 05 29

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.

1.3 ACTION SUBMITTALS

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

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

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

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

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch or Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

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

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
7. Identification of potable and non-potable water.

    a. In all buildings where two or more water distribution system, one potable water and the other non-potable water, ate installed, each system shall be identified either by color marking or metal tags as required by ASME A13.1. Reclaimed water systems shall be identified using color coded Pantone Purple 522C and marked with the statement “NONPOTABLE WATER - NOT FOR HUMAN CONSUMPTION.

B. Pipe Label Color: Refer to ASME(ANSI) Standard A13.1-2007.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Provide a valve chart in each mechanical and custodial room indicating the quantity, type and system the valve serves. Chart information shall indicate job name, Contractor name, date of installation, valve number, valve location, valve type, valve purpose, and system in which installed. Mount framed chart in equipment room, and insert copy of chart in each operating and maintenance manual under separate tabbed section labeled "Valve Chart". Where project drawings include a piping flow schematic, request AutoCad file from Engineer and label all of the valves according to the valve chart and frame in an 18” x 24” frame in main mechanical or pump room.

C. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme. Captions should include piping service (CW, HW, HWR) and valve number. Provide a marker for each valve and equipment to be tagged, and permanently adhered to the ceiling metal grid below the valve. The information on this tag shall match the tag on the valve and include valve service and number.

1. Valve-Tag Size and Shape:
    a. Cold Water: 2 inches, round.
    b. Hot Water: 2 inches, round.

END OF SECTION 22 05 53

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SECTION 22 05 76 - FACILITY DRAINAGE PIPING CLEANOUTS

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 WORK INCLUDED

A. Cleanouts.

1.3 SUBMITTALS

A. Submit shop drawings in accordance Division 01 for submittal requirements.

B. Each cleanout submittal must be marked to show what area it will be used.

1.4 JOB CONDITIONS

A. Provide protection for all cleanouts against damage during construction. The plumbing contractor shall be responsible to replace any damaged cleanouts.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The manufacturers referenced herein are those that the specifications and drawings are based on. Equipment by other manufacturers will be considered provided all requirements and intent of the specifications are met.

2.2 MATERIALS

A. Cleanouts:

1. Floor Type (FCO):

a. Finished Floors - Cast iron adjustable floor level cleanout assembly with round nickel bronze top and plug, with inverted hub and neoprene gasket.

J. R. Smith Fig. 4033-L
MIFAB #C1100-R
Watts #CO-200-R
Zurn # ZN1400-BP
Wade #6000-1-75

b. Terrazzo Floors - Cast iron adjustable floor level cleanout assembly with round nickel bronze top and plug, with center lifting device. Top depression to be filled with terrazzo and finished.

J. R. Smith Fig. 4180, Gasket #4193
MIFAB #C1100-UR
Watts #CO-200-LL
Zurn # Z1400-Z-BP
Wade #6000U-1

2. Above Floor (CO):

a. Caulk Ferrule Cleanouts - Cast iron ferrule with countersunk bronze plug.
J. R. Smith Fig. 4420
MIFAB #C-1450
Watts #CO-380
Zurn # Z1400-BP
Wade #8550E

3. Wall Type (WCO):

a. Wall-Round Cover - Cast iron ferrule with lead seal plug, round stainless steel cover with center screw.
J. R. Smith Fig. 4402
MIFAB #C1450-RD
Watts #CO-380-RD
Zurn # Z1441
Wade 8550E-8480R

b. Wall-Round Cover - Cast iron ferrule with lead seal plug; chrome plated bronze round frame and cover secured with slotted screws for "face-of-wall".
J. R. Smith Fig. 4432
MIFAB #C1300-R
Watts #CO-300-R
Zurn # ZB 1444
Wade #8480C

4. Exterior Type (ECO):

a. Exterior Clean Out - Cast iron adjustable finish slab level cleanout assembly with round nickel bronze top and plug, with inverted hub and neoprene gasket. When installed in finish slab to of clean out shall be installed flush. Top of clean out shall not protrude of finish slab and create tripping hazard. When installed on grade provide 18”x18”x9” concrete pad for support of clean out and piping.

ZN1406-BP
Watts #CO-200-RX4

PART 3 - EXECUTION

3.1 INSTALLATION

A. Cleanouts:

1. Provide cleanouts in all locations shown on the drawings and in all other locations required by The Local Building Code, and as directed by the Local Inspector.
2. Where special conditions exist, such as the need for a shallow cleanout to meet invert elevations, make changes necessary at no change in contract price and submit drawings or description for approval if requested by the Architect.
3. Cleanouts shall be the same size as the pipes they serve up to 4 inch, and not less than 4 inch for piping of larger size.
4. Cleanouts shall be installed not more than 100 feet apart in horizontal drainage piping where two-clean out fitting is utilized and 50 feet where one directional fitting is utilized.
5. Cleanouts shall be installed in the horizontal piping at each change of direction of the building waste, soil and storm systems greater than 45 degrees.
6. A cleanout shall be installed at or near the base of each waste, soil or rainleader

stack.

7. All work this section shall conform to local building/plumbing code.

END OF SECTION 22 05 76

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SECTION 22 05 77 - FACILITY PLUMBING DRAINS AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Floor Drains.

B. Floor Sinks

C. Hub Drains.

D. Backwater Valves.

E. Trap Guards.

F. Bi-Functional Roof Drains

G. Downspout Nozzles

1.3 SUBMITTALS

A. Submit shop drawings in accordance with Division 01 Requirements.

B. Each drain submittal must be marked to show what area it will be used.

1.4 JOB CONDITIONS

A. Provide protection for all drains and cleanouts against damage during construction. The Plumbing Contractor shall be responsible to replace any damaged drains.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The manufacturers referenced herein are those that the specifications and drawings are based on**.** Equipment by other manufacturers will not be considered, no substitutions.

2.2 MATERIALS

A. Floor Drains:

1. FD-1: Toilets - Cast iron body, flashing clamp and adjustable square nickel bronze top secured with vandal proof screws. Provide with “P” trap and trap guard.

   J. R. Smith Fig. 2010-B
   Josam 30000-S
   Watts FD-100-M5-7
   Zurn ZN415-SS-0

2. FD-2: Mechanical Room Floor Drain - Cast iron body, flashing clamp and adjustable round nickel bronze top. Provide with sediment bucket and “P” trap with trap guard.

   J. R. Smith Fig. 2010-B

Josam 30000-E-80
Watts FD-100-B-P-B8-5
Zurn ZN415-HD-6B-Y

3. FD-3: Ice Machine - Cast iron body, flashing clamp and adjustable round nickel bronze top with funnel and secured with vandal proof screws. Provide with “P” trap and trap guard.

J. R. Smith Fig. 3510Y
Josam 30000-E2
Watts FD-100-EF
Zurn ZN415B-4

B. Hub Drains:

1. HD-1: Cast iron body, flashing clamp, water dam, cast iron dome strainer secured with vandal proof screws. Provide with deep seal "P" trap and trap guard. Hub drain lip should not be more than ½” above slab.

J. R. Smith Fig. 3960
Josam 25540
Watts RD-200-R-LD-DS-L
MIFAB R1100-RS
Zurn Z127

C. Backwater Valve:

1. BWV-1: Coated cast iron backwater valve, offset type, bronze fixed swing-check assembly, bolted gasketed cover, and no-hub connections. Provide HDPE valve box for valve installation.

Josam 67400
Watts BV-200
MIFAB BV1000
Zurn Z1090
JR Smith 7012

E. Trap Guard:

1. Trap Guard – Elastometric tubing device molded to prevent sewer gasses from escaping through P-Traps.

Sure Seal
Proset

F. RD-1: Bi-functional roof drain body to be used on flat roof construction. Powder coated, ASTM A 48, Class 25 cast iron body with anchor flange. Cast Iron strainer. Min: Free area of 136 square inches. Membrane Clamp Ring shall be 2.375-inch wide, ASTM A 48, Class 25 cast iron, waterproofing membrane clamp ring with integral gravel stop. Provide extension as required for installation of roof drain.

Zurn Z103-20F
Watts RD-700

G. Downspout Nozzles:

1. DSN-1: Nickel bronze body, threaded inlet and decorative face of wall flange and outlet nozzle.

Watts RD-940
Zurn ZN-199

PART 3 - EXECUTION

3.1 INSTALLATION

A. Drains:

1. Unless otherwise specified, drains to be complete with strainers, trim, flashing and appurtenances and constructed of cast iron with painted finish.
2. Set all floor drains level and at proper elevations to surrounding floor area to provide smooth and uniform drainage area.
3. Unless noted otherwise, provide a trap for each floor drain of a material to match the pipe line to which it discharges.
4. Provide drains in all locations shown on the Architectural and Plumbing drawings. Drains to be of the types specified herein and sized as shown on the plumbing drawings. Refer to the Architectural drawings for additional installation details.
5. Actual sizes and quantities of all drains shall be determined from the drawings.
6. Trap Primers shall not be used. Drains shall be installed with Trap Guards.

END OF SECTION 22 05 77

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SECTION 22 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Piping Systems Insulation.

B. Accessories.

1.3 QUALITY ASSURANCE

A. All products within the conditioned air stream or active plenums shall comply with the NFPA 90A Flame/Smoke rating of 25/50 and comply with UL 181 erosion limitations. Fire hazard ratings shall be as determined by NFPA-255, "Method of Test of Surface Burning Characteristics of Building Materials" - ASTM E84 or UL 723.

B. All adhesives, cements, finishes, jackets, etc., shall be UL listed or labeled for use as applied to insulation and designed specifically for use in the installation.

C. All insulation shall be installed in accordance with National Commercial & Industrial Insulation Standards (NCIA).

1.4 SUBMITTALS

A. Submit schedule indicating type of insulation, thickness, vapor barrier or coating by system and size.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

C. Submit details of insulated removable covers using the actual equipment dimensions, concrete base sizes and piping arrangements.

D. Refer to Division 01 for submittal requirements.

1.5 GENERAL REQUIREMENTS

A. Factory-applied insulation is specified under the applicable equipment Section of these specifications. It is listed here for reference only.

B. Packages and standard containers of materials shall be delivered unopened to job site and shall have the manufacturer's label attached giving a complete description of the material.

1.6 DEFINITIONS

A. The term "exposed" means exposed to view in finished spaces, in equipment rooms, in fan rooms, in closets, in utility corridors, on roof, in storage rooms, and in other spaces as indicated.

B. The term "concealed" means concealed from view, and includes all spaces not defined as

exposed.

C. The term "unconditioned" space shall mean all places where the temperature surrounding the pipe has not been conditioned consistent with conditioned spaces, and shall include mechanical equipment rooms, non-active ceiling plenums, and non-accessible chases. This term shall also include conditioned spaces where the humidity levels are allowed to rise above 70% RH.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Fiberglass Insulation:

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

B. Closed Cell Elastomeric Insulation:

1. Armacell LLC
2. Johns Manville
3. Rubatex

2.2 PIPE INSULATION REQUIREMENTS

	Thickness	Type
A. Condensate Drain (C):		
All Sizes	1/2"	Closed Cell Elast.
B. Dom. Cold Water (CW):		
Up to 4”	--	Not Required
C. Dom. Hot Water (HW):		
Conditioned Space		
Up to 1-1/4”	1”	Rigid Fiberglass
1-1/2” through 4	1-1/2"	Rigid Fiberglass
Unconditioned Space		
Up to 1-1/4”	1”	Rigid Fiberglass
1-1/2” through 4	1-1/2"	Rigid Fiberglass

D. All exposed piping on the exterior of the buildings shall be insulated with Armorflex insulation, 1” thick with metal jacket.

E. Hub Drains Receiving Condensate – All Sizes	1/2”	Closed Cell Elast.
F. Fire Resistive Pipe Wrap:	2”	3M™ FireBarrier 20A,

1. Tapes:

a. High performance filament tape.

b. Aluminum foil tape: Minimum 3” wide to seal cut blanket edges.

2. Banding Material

a. Carbon steel banding for ≤ 1-hour ratings; ½” to ¾” wide x 0.015” thick minimum.
b. 304 Stainless Steel banding for 2-hour ratings; ½” to ¾” wide x 0.015” thick minimum.

2.3 MATERIALS

A. Pipe Insulation (to 450F):

1. Rigid Fiberglass: Resin bonded fibrous glass, flame retardant, factory applied all service jacket vapor barrier with self sealing pressure sensitive lap joints, molded to accommodate pipe, maximum vapor permeance of .02 perm/in. and a puncture resistance of 50 units, minimum density 4.0 lb/cf, maximum conductivity per 1" thickness of .23 at 75°F, .29 at 200°F and .43 at 400°F mean temperature. Based on Knauf Pipe Insulation.
2. Closed Cell Elastomeric (Small Pipe Sizes up to 5 Inches): Flexible, elastomeric, closed cellular, tubular molded to accommodate piping, smooth outer surface suitable for painting with vinyl lacquer type coating, water resistant, non absorbent, ozone resistant, minimum density of 4 lb/cf, maximum conductivity per 1" thickness of .27 at 75°F mean temperature. Based on Armacell LLC AP Armaflex and Self-seal Armaflex 2000.

B. Accessories:

1. Corner angles shall be minimum 28 gauge, 1 inch by 1 inch aluminum adhered to 2 inch by 2 inch heavy kraft paper.
2. Glass tape shall be a minimum density of 1.6 ounces per square yard, 4 inch wide with a 10 x 10 thread count per inch of width. Glass cloth shall be untreated.
3. Staples shall be outward clinching type, Type 304 or 316 stainless steel in accord with ASTM A 167 or Monel® coated.
4. Wire shall be soft annealed galvanized, or copper, 16 gauge, or nickel copper alloy.
5. Closed cell elastomeric insulated finish shall be a white water based flexible, acrylic latex enamel equal to WB Armaflex finish.
6. Insulation Tape: Closed cell elastomeric insulation: 2" wide x 1/8" thick.
7. Elastomeric Insulation Adhesive: Air drying contact adhesive for securing sheets to flat or curved metal surfaces and joining seams and butt joints of elastomeric insulation. Suitable for temperatures to 180F, dried film not to exceed 25 for flame spread and 50 for smoke development when tested per ASTM E 84-84A method.
8. Vapor Barrier Mastic: Air drying flexible water based mastic used for applying a vapor barrier joint with glass cloth at insulation joints. Suitable for temperatures to 180°F, wet and dried film not to exceed 25 for flame spread and 50 for smoke development when tested per ASTM E 84-84A method. Maximum Perm rating of 0.08. , Childers Products Company, Inc. CP-35 Chil Therm® WB, Foster Products Corp. Product Data 30-80 Foster Vapor Safe® Coating, Marathon Industries, Inc. 590 LO-PERM, Richard’s Paint Manufacturing CO., Inc. VBM-4, Vimasco Corp. 749 Vapor-Blok, or equal.
9. Acrylic Latex Finish and Sealers:

a. Elastomeric Insulations: Air drying flexible water based finish used for finishing flexible elastomeric insulation. Suitable for temperatures to 180°F, wet and dried film not to exceed 25 for flame spread and 50 for smoke development when tested per ASTM E 84-84A method. Armacell LLC WB

Armaflex finish.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Install all insulation in strict accordance with the manufacturers written installation instructions.

B. All insulation work shall be performed by skilled mechanics regularly engaged in the insulation trade.

C. Properly coordinate the insulation work with the other trades so that installation is performed with a minimum of conflict.

D. Insulation shall not be applied on any piping system requiring testing until testing is completed and approved by Engineer of Record.

E. Insulation shall not be applied until all systems are clean, dry, free of dirt, dust or grease.

F. The finished installation shall present a neat and acceptable appearance which includes but is not limited to: all jackets smooth, all vapor barriers sealed properly, no evidence of "ballooning" of the jackets, or sagging insulation, all valves, dampers, gauges, unions, etc. accessible. The Owner's Representative shall be the final judge of acceptance of workmanship.

G. All equipment nameplates on hot equipment shall be left uncovered. All equipment nameplates on cold equipment shall have a removable section sized to expose the name-plate. This section shall be clearly marked "NAMEPLATE".

H. If proper maintenance procedures require access to the insulated equipment removable panels, sections or covers shall be provided to accomplish this. These access devices shall be constructed in a manner to assure easy access and sturdy construction. The contractor shall assume the responsibility to coordinate all equipment requiring insulation to be either factory or field insulated.

I. Insulation and accessories shall be applied only at suitable application temperature and conditions as recommended by the manufacturer. Do not apply insulation to any surface while it is wet.

J. Insulation shall be protected from moisture and weather during storage and installation.

K. Insulation which has sustained moisture damage, torn jackets, or other damage due to improper storage or other reasons shall not be used. If evidence of this is sighted the Owner's representative reserves the right to require the insulating contractor to remove any and/or all insulation until the Owner's Representative is satisfied that there is no longer any inferior insulation installed on this project.

L. Insulation, fabric and jacketing shall be protected from damage during construction. Damage by the insulator shall be repaired without cost to the Owner. Damage by others shall be reported in writing to the contractor.

M. The insulation subcontractor is responsible for proper material storage at the work site.

N. Work performed prior to receipt of approved documents or submittals, later proving to be incorrect or inappropriate, shall be promptly replaced by the contractor without cost to the

purchaser.

O. Insulation shall not be installed until adequate access and clearances at control mechanisms, dampers, sleeves, columns and walls have been provided.

P. All insulation at handholds, access doors or other openings, and adjacent to flanges and valves shall be neatly finished where exposed to view.

Q. All materials, accessories and methods of installation and fabrication are subject to the Owner's Representatives inspection and approval during any phase of the work.

R. The insulation subcontractor shall prevent the accumulation of insulation debris in the buildings and on the premises of the Owner.

S. The insulation subcontractor shall be responsible for his own safety program at the work site, and shall provide instruction on safe practices for his workers assigned to the project. All employees are subject to the work rules at the job site.

T. The insulation subcontractor shall familiarize himself with the progress and execution of the job and notify the proper parties of interferences and any problems with the proper installation of his materials.

3.2 INSTALLATION

A. Pipe Insulation:

1. General:

a. All locations where the insulated surface is supported by hangers, the insulation shall be protected by shields or saddles properly skimmed to maintain a smooth outer surface, and proper insulation thickness. If the possibility exists that the hanger may conduct the temperature of the conveyed medium and thus cause condensation or personal injury due to high temperature, the hanger shall also be insulated. Joints between foamglas and pipe insulation shall be properly sealed.

b. All devices connected to or in line with the piping system shall be insulated greater than or equal to the connecting piping. This includes but is not limited to valves, air separators, expansion tanks, control valves, control devices, gauge connections, thermometer stems, chemical feed equipment, piping flexible connectors, etc. This is particularly important on ice water and refrigerant lines.

c. The insulation at threaded unions in hot water piping shall be tapered and terminated with cement and glass lagging cloth and lagging adhesives.

d. A complete moisture and vapor barrier shall be installed wherever insulation is penetrated by hangers or other projections through insulation and in contact with cold surfaces for which a vapor seal is specified.

e. Cover fittings, flanges, unions, valves, anchors, and accessories with premolded or segmented insulation of the same thickness and material as the adjoining pipe insulation. Where nesting size insulation is used overlap pipe insulation 2 inches or one pipe diameter. Fill voids with insulating cement and trowel smooth. Elbows shall have not less than 3 segments per elbow. Secure insulation with wire or tape until finish is applied. Blanket inserts in lieu of premolded or segmented insulation is not allowed. Cover fittings with preformed PVC fitting covers.

f. Wrap all pressure gauge taps, thermometer wells and all other penetrations through insulation with closed cell insulation tape so as to prevent

condensation.

g. Seal all raw edges of insulation.

h. For piping supported by hangers outdoors, apply a rainshield to prevent water entry.

2. Rigid Fiberglass:

a. Provide PVC fitting covers for all fittings.

b. Align all jacket seams.

c. Assure all vapor barriers are properly sealed.

d. Provide PVC jacket over all exposed insulation in the equipment room.

e. All corner angels below 6’-10” shall have padded insulation and be marked with yellow stripes.

3. Closed Cell Elastomeric:

a. All joints shall be sealed with adhesives.

b. Where the thickness is to be obtained by use of two layers of insulation, install with staggered joints.

c. Finish:

1) Concealed Indoors: No additional finish.

2) Exposed Indoors: Provide PVC jacket over all insulation.

3) Concealed Indoors: Provide PVC jacket over fittings fabricated from insulation sections or sheet.

4) Outdoors: Provide aluminum pipe jacket.

END OF SECTION 22 07 00

SECTION 22 11 16 - DOMESTIC WATER 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 WORK INCLUDED

A. Domestic Water (CW/HW) Piping.

1.3 DEFINITIONS

A. The pipe sizes given in this document shall be construed nominal.

1.4 QUALITY ASSURANCE

A. All material provided under this section shall be standard catalogued products of recognized manufacturers regularly engaged in the production of such products, and shall be of the manufacturer's most recent design that is in regular production.

B. Each item provided under this section shall meet the requirements for that item as installed and used, in accordance with the following standards:

1. All other metallic piping - ASME/ANSI B31.1

C. Each piping system shall be in accordance with the system design pressures shown in paragraph 2.1 - Materials, this specification section.

D. All materials provided under this section shall be new, except where the specifications and/or drawings permit the reuse of certain existing materials.

E. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.5 SUBMITTALS

A. All submittals shall be made in accordance with Division 01 Requirements.

B. Submit a list identifying the specific type of material that will be used for each piping system. Include pipe, pipefittings, valves and joints. Include the basic designation of the publication applicable for each type of material and method.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Domestic (Potable) Water (CW/HW) Piping
System Design Pressure: 150 psig.

a. Piping, 8" and smaller - Above grade, copper tube, Type “L”, hard temper, ASTM B88. Wrought cooper or bronze fittings, solder joint, pressure rated, ASTM B16.22-95; or cast bronze fittings, solder joint, pressure rated, ASME B16.18-R94. All valves shall be brass. Plastic

valves are not acceptable.

1. Piping, 4” and smaller – Below grade, copper tube, Type “K”, hard temper, ASTM B88. Wrought copper or bronze fittings, solder joint, pressure rated, ASTM B16.22-95; or cast bronze fittings, solder joint, pressure rated, ASME B16.18-R94.
2. Temperature and pressure relief lines and drain pan lines same as domestic water, Type “L” hard-drawn copper in a return air plenum.
3. Piping above slab/grade pipe, size 1/2” to 2-1/2” may be Type “L” ASTM B-88 copper tubing.
4. Pipe Fittings, 8" and smaller - Above ground installation may be:

    a. Wrought Copper, ANSI B16.22.

5. Pipe Fittings, 4" and smaller - Below ground installation: Wrought Copper, ANSI B16.22.
6. Solder for factory fabricated fittings: Lead-free per FPC.
7. Brazing for Mechanically formed tee fittings: Brazing may be:

    a. 5% silver, 6% phosphorus, balance copper, 1190°F melting point. AWS A5.8 number BCuP -3. J.W. Harris Stay-Silv® 5 or approved substitution.
    b. 15% silver, 5% phosphorus, balance copper, 1190°F melting point. AWS 5.8 number BCuP-5. J.W. Harris Stay-Silv® 15 or approved substitution.
    c. 6% silver, 6.1% phosphorus, balance copper, 1190°F melting point. QQ-B-654A number BCuP -5. J.W. Harris Dynaflow® 5 or approved substitution.

8. Fittings and couplings shall be UL classified in accordance with ANSI / NSF-61 for potable water service, and shall meet the low lead requirements of NSF-372.

2.3 PRESS FITTING SYSTEMS - (ProPress or equal) press fittings are allowed in domestic water piping, grooved fittings are not acceptable.)

A. General:

1. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press end shall have design feature that allows leakage at fittings that have not been pressed. The function of this feature is to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.
2. 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 tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Furnish and install piping, fittings and appurtenances required to complete the piping systems shown on the drawings. Elbows shall be long radius type. Tees may not be field fabricated.
2. Run piping to true alignment, generally parallel or perpendicular to building walls, floors and ceilings, and with uniform grades and spacing, so as to present a neat and workmanlike appearance.
3. Care shall be paid to the exact locations of piping with respect to equipment, ducts, conduits, slabs, beams, lighting fixtures, columns, ceiling suspension systems, etc. to provide maximum access to mechanical and electrical equipment in the building. Close coordination and cooperation shall be exercised with other trades in locating the piping in the best interests of the Owner. The drawings and specifications covering other work to be done in the building shall be carefully studied and arrangements made to avoid conflict.
4. Not all necessary pipe offsets are indicated on the drawings because of the small scale. The various runs of piping to be installed shall be studied and adjustments made in exact routings as may be required for proper installation.
5. Conflicts arising during the erection of piping shall be brought to the attention of the Owner's Representative and Engineer of Record. No improvising or field changes will be permitted without the approval of the Engineer of Record.
6. Use full lengths of pipe wherever possible. Short lengths of pipe with couplings will not be permitted. Cut to exact measurement and install without forcing or spring unless otherwise shown on the drawings or specified.
7. Avoid tool marks and unnecessary pipe threads. Burrs formed when cutting pipe shall be removed by reaming. Before installing any pipe, care shall be taken that the inside is thoroughly cleaned and free of cuttings and foreign matter. Measures shall be taken to preserve this cleanliness after erection.
8. Arrange pipe connections to valves and specialties so that there is clearance for easy removal of the valve or specialty from the line, and also for the removal of the valve bonnet and interior, and the specialty top and bottom and interior, except where otherwise approved by the Engineer of Record.
9. Erect piping in such a manner so as to obtain sufficient flexibility and to prevent excessive stresses in materials and excessive bending movements at joints or connections to equipment. Make allowances throughout for expansion and contraction of piping. Provide each riser and horizontal run of piping with expansion loops, expansion joints, or expansion compensators where indicated and required. Securely anchor and adequately guide pipe as required or where indicated to force expansion to the expansion device without bending, binding, or misalignment of pipe. Branch connections from mains to risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Where indicated, in lieu of expansion loops, expansion joints, or expansion compensators, horizontal runs of pipe shall be anchored at approximately midway of the run to force expansion, evenly divided, toward the mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining.
10. Installed piping shall not interfere with the operations or accessibility of doors or windows and shall not encroach on aisles, passageways and equipment, and shall not interfere with the servicing or maintenance of any equipment. Adjacent pipelines shall be grouped in the same horizontal or vertical plane.
11. Use building steel wherever possible for supporting pipe hangers. Main structural steel shall not be drilled, cut or burned for hangers without the approval of the Structural Engineer of Record. Expansion bolts shall be used only upon the approval of the Structural Engineer of Record.
12. Install unions or flanges in piping connections to equipment, regulating valves, and wherever necessary to facilitate the dismantling of piping and/or removal of

valves and other items requiring maintenance.

a. Unions and flanges for servicing and disconnect are not required in installations with grooved mechanical joint couplings. (The couplings shall serve as disconnect points.)

13. Avoid bushings. Reducing fittings shall be used wherever practical.
14. The drawings indicate the size of piping and connections, and if certain sizes are omitted or unclear, obtain additional information before proceeding.
15. The piping drawings have been worked out with a view to the most economical installation, taking into consideration accessibility and appearances, and the Contractor must follow the drawings accurately and if it is found impractical to install the work in accordance with the drawings and specifications, the Contractor shall notify the Engineer of Record before making any changes and get their approval or revised drawings before proceeding with the work. Verify all measurements on the job before cutting pipes or having piping fabricated, and be responsible for the correct location of all pipe connections, also check sizes and standard of outlets on the equipment, including the dimensions and drilling of flanges, etc.
16. Copper tubing and galvanized steel shall not be mixed in any one run of piping.
17. Change in direction shall be made with fittings, except that bending of steel and copper pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations is not acceptable.
18. Threaded joints shall be made with tapered threads in accordance with ANSI B2.1, and made tight with an approved pipe thread joint compound or material, applied to the male threads only. Use compounds sparingly and apply with caution to ensure that compounds do not enter piping systems. When pipe joint is made up a maximum of 3 threads shall be visible.
19. Joints for plastic pipe shall be made in accordance with PPI Piping Manual.
20. Connections between ferrous and nonferrous metallic pipe shall be made with dielectric unions or flanges.
21. Connections between plastic and metallic pipe, between plastic and glass pipe, and between metallic and glass pipe, shall be made with transition fittings manufactured for the specific purpose.
22. Unions and flanges shall not be concealed in walls, partitions, or above inaccessible ceilings.

B. Plumbing Systems Additional Requirements:

1. Bends, plugs, or tees in water service lines, except soldered or screwed joints, shall be braced or clamped. The connection between the water service line and the domestic water distribution line shall be anchored by means of tie rods and pipe clamps.
2. Before connecting the domestic water system to underground supply connections, each supply connection shall be thoroughly flushed of all foreign matter.
3. The underground water service pipe and the building sewer shall be not less than 5 feet apart horizontally, and shall be separated by undisturbed, or compacted, earth, unless the following requirements are satisfied:

a. The water service pipe and the building sewer may be installed in the same trench, provided written approval is given by the plumbing official and the following conditions are met:

1) The bottom of the water service pipe at all points shall be not less than 12 inches above the top of the sewer line at its highest point.
2) The water service pipe shall be placed on a solid shelf excavated at one side of the common trench.
3) The number of joints in the service pipe shall be kept to a minimum.
4) The materials and joints in the sewer pipe shall be installed in such manner, and shall possess the necessary strength and durability, to prevent the escape of solids, liquids, and gases there from under all known adverse conditions such as corrosion, strains due to temperature changes, settlements, vibration, and superimposed loads.
5) Where the water service line must cross the building sewer line, the bottom of the water service line within 10 feet of the point of crossing shall be at least 12 inches above the top of the sewer line. The sewer line shall be of cast iron, with leaded or mechanical joints, within 5 feet of the point of crossing.
6) Domestic water lines shall be disinfected.

4. If applicable, provide access panel for all valves located above non-accessible ceiling. Coordinate with Architectural plans for exact locations.
5. Provide clean-outs at the base of all sanitary waste and vent stacks.
6. Installation of copper tubing shall be per FPC, ASTM B32-96, and per Copper Development Association and ASTM B828-92-E01.
7. Install plugs or caps on all openings during the construction phase. The temporary plug shall be cap of same material as pipe. Duct tape is unacceptable for use as a plug for the construction phase.
8. All penetrations of piping through walls shall be made insect proof, (i.e., penetrations of waste arms, hot and cold water piping through walls below sinks, lavatories, water closets, etc.). The escutcheon plate does constitute an “insect proof” closure.
2. Teflon tape shall be used on threaded connections. Expansion loops on hot water system shall be installed per manufacturer’s instructions to suit temperature and pipe run.

C. Press Fitting System Additional Requirements: Install in strict accordance with the manufacturers’ written installation instructions. Tools shall be calibrating per manufacture’s requirements and shall be maintained per manufacturer’s schedule.

3.2 BRAZING, AND SOLDERING

A. Operator and Procedure Qualifications: All brazing operators and all brazing procedures shall be qualified in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

B. Brazing: Silver braze joints in accordance with MSS-SP-73 "Silver Brazing Joints for Wrought and Cast Solder Joint Fittings".

C. Soldering: Joints in copper tubing shall be made with solder- type fittings. Outside surface of the tube where engaged in the fitting, and inside surface of the fitting in contact with the tube, shall be cleaned with an abrasive material before soldering. Self- cleaning compounds shall not be used. Care shall be taken to prevent annealing of tube and fittings when making connections. The solder joint shall be made with flux and wire form solder, except brazed joints. The flux shall be a mildly corrosive liquid or a petroleum based paste containing chlorides of zinc and ammonium. Solder shall be applied and

drawn through the full fitting length. Excess solder shall be wiped from joint before solder hardens. Joints in copper tube sizes 2-1/2 inches and larger shall be made with heat applied uniformly around the entire circumference of the tube and fittings by a multi-flame torch. Use of oxy-acetylene cutting torch in lieu of multi-flame torch is not permitted. Disassemble valves and other accessories that may be damaged by heat before soldering.

3.3 TESTING OF PIPING SYSTEMS:

A. Each piping system, after erection, shall be subjected to a pressure test. The test requirements shall be as follows:

1. Plumbing related systems shall be tested with water at not less than a 10 foot head. The water shall be kept in the systems for a period of not less than 15 minutes prior to start of visual examination. In lieu of water test, the systems may be tested with air at a uniform pressure of 5 psig, with no loss in pressure for a period of not less than 15 minutes.
2. Domestic Water Distribution Systems shall be tested with water at the system working pressure, but not less than 100 psig. Joints will be visually examined for leaks.
3. Domestic Water Distribution Systems utilizing Viega Pro-*Press* fittings with SC Feature Contour Design shall be initially tested at a minimum of ½ psig but not more than 85 psig. Joints shall be visually examined for leaks.
4. Domestic Water Service System shall be tested with water at 150 psig. Joints will be visually examined for leaks.
5. Leaks, if any, shall be located, repaired, and retested in accordance with the test method specified for the system in which the leaks are located.

B. Prior to testing a system, the Contractor shall provide the proper Building Official and the Owner's Representative with not less than 72 hours notice of the proposed test. The Contractor shall obtain approval of the test results. Where written approval is required, the Contractor shall obtain such written approval, and submit a copy of the approval.

C. Work requiring testing shall not be covered, or otherwise concealed, until testing is completed and approval is granted.

D. Work, or portions of work, that is altered in any way after testing and approval shall be retested, witnessed, and approval obtained.

E. Systems requiring hydrostatic tests shall be protected from damage caused by freezing. After tests are completed drain all sections of pipe, including traps, or fill undrained sections and traps with antifreeze solution. Vent all high points to release vacuum and ensure complete drainage of closed systems, and blow out piping with compressed air to remove trapped water.

F. Duration of tests, unless specified otherwise, shall be the time required to examine each joint in the system being tested.

G. Systems requiring hydrostatic testing under pressure shall be vented at high points to ensure that all piping is completely filled with the testing medium.

H. Disconnect pressure boosting apparatus, or vacuum pumps, during the test time span specified for systems employing the pressure loss/time span test method.

I. During tests, isolate system components that have test pressures less than pressures specified for system tests.

J. Use clean soapy water applied to exterior of joints to locate leaks in systems using compressed air, dry carbon dioxide, or nitrogen, under positive pressure as a test medium.

3.4 CLEANING OF PIPING SYSTEMS

A. Plumbing piping systems shall be thoroughly cleaned as described in Section 22 11 17 - Disinfection of Domestic Water Lines. The chlorination and disinfections process shall be witnessed by a representative of the owner and provide a written Certification, as such.

END OF SECTION 22 11 16

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SECTION 22 11 17 - DISINFECTION OF DOMESTIC WATER LINES

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 WORK INCLUDED

A. Provide personnel, equipment and supplies, disinfect domestic hot and cold water systems, and flush out systems at completion of treatment.

1.3 DEFINITIONS

A. Disinfectant Residual means the quantity of disinfectant in treated water.

B. pH Factor means the measure of alkalinity and acidity in water.

C. ppm means parts per million.

1.4 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this Section to the extent referenced.

1. American Waterworks Association (AWWA) Standards.
2. Standard Methods for the Examination of Water & Waste Water (14th edition).

1.5 QUALITY ASSURANCE

A. Water Treatment Contractor: At least 5 years experience performing work specified herein.

B. Bacteriological Laboratory: State certification.

1.6 SUBMITTALS

A. General: Submit product literature for approval in accordance with Division 01.

B. Water Treatment Contractor's evidence of experience: Submit three (3) copies.

C. Bacteriological Laboratory's evidence of certification: Submit three (3) copies.

D. Test Reports: Submit four (4) copies as follows:

1. Disinfection Report, include:

a. Date issued.
b. Project name and location.
c. Treatment Contractor's name, address, and phone number.
d. Type and form of Disinfectant used.
e. Time and date of Disinfectant injection start.
f. Time and date of Disinfectant injection completion.
g. Test locations.
h. Initial and 24 hour Disinfectant Residuals in ppm for each outlet tested.
i. Time and date of flushing start.
j. Time and date of flushing completion.

k. Disinfectant Residual after flushing in ppm for each outlet tested.

2. Bacteriological Report. Include:

a. Date issued.
b. Project name and location.
c. Laboratory's name, certification number, address, and phone number.
d. Time and date of water sample collection.
e. Name of person collecting samples.
f. Test locations.
g. Time and date of laboratory test start.
h. Coliform bacteria test results for each outlet tested.
i. Certification that water conforms or fails to conform to bacterial standards or fails to conform to bacterial standards of Federal Safe Drinking Water Act.
j. Bacteriologist's signature.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Protect against damage and contamination.

B. Maintain caution labels on hazardous materials.

C. Maintain storage room dry and with temperatures as uniform as possible between 60°F and 80°F.

D. Do not store Caustic Soda directly on floor colder than 55°F.

1.8 PROTECTION

A. Provide necessary signs, barricades, and notices to prevent any person from accidentally consuming water or disturbing system being treated.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall conform to the respective publications and other requirements specified herein.

B. Disinfectant: Free chlorine; liquid, powder, tablet, or gas.

C. Alkali: Caustic Soda or Soda Ash.

D. Acid: Hydrochloric (Muriatic) type.

PART 3 - EXECUTION

3.1 INSPECTION

A. Prior to starting work verify that domestic water system is completed and cleaned.

B. Notify Contractor about defects requiring correction.

C. Do not start work until conditions are satisfactory.

3.2 PREPARATION OF WATER FOR TREATMENT

A. Verify pH factor of water to be treated.

B. If pH factor is less than 7.2, introduce sufficient Alkali during Disinfectant injection.

C. If pH factor is greater than 7.6, introduce sufficient Acid during Disinfectant injection.

3.3 SYSTEM TREATMENT

A. Injection Disinfectant throughout system to obtain 50 to 80 ppm residual.

B. Starting at outlet closest to water source, bleed water from each outlet until water produces odor of Disinfectant. Repeat process at each outlet throughout system. If odorless Disinfectant is used testing is required to determine if Disinfectant is fully dispersed throughout system.

C. Test for Disinfectant Residual at each of the following locations:

1. Ends of piping runs.
2. Remote outlets.
3. At least 15% of outlets on each floor where directed by Architect, but in no case less than 2 outlets.

D. Maintain Disinfectant in system for 24 hours.

E. If Disinfectant Residual is less than 25 ppm, repeat system treatment.

3.4 FLUSHING

A. Remove Disinfectant from system; permit no more than residual rate of incoming water or 1.0 ppm, whichever is greater.

3.5 BACTERIOLOGICAL TEST

A. Instruct Bacteriological Laboratory to take water samples no sooner than 24 hours after flushing system.

B. Take water samples at each of the following locations:

1. Where water enters system.
2. Ends of piping runs.
3. Remote outlets.
4. At least 10% of outlets on each floor other than those used for testing Disinfectant Residual, where directed by Architect, but in no case less than two (2) outlets.

C. Analyze water samples in accordance with AWWA Standard Methods for the Examination of Water & Waste Water, 14th edition.

D. If bacteriological test proves water quality to be unacceptable, repeat system treatment until water quality is acceptable.

END OF SECTION 22 11 17

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SECTION 22 13 16 - SANITARY DRAIN, WASTE AND VENT 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 WORK INCLUDED

A. Sanitary Drain, Waste and Vent (DWV).

1.3 DEFINITIONS

A. Pipe sizes given in this document are nominal.

1.4 QUALITY ASSURANCE

A. All material provided under this section shall be standard catalogued products of recognized manufacturers regularly engaged in the production of such products, and shall be of the manufacturer's most recent design that is in regular production.

B. Each item provided under this section shall meet the requirements for that item as installed and used.

C. Each piping system shall be in accordance with the system design pressures shown in paragraph 2.1 - Materials, this specification section.

D. All materials provided under this section shall be new, except where the specifications and/or drawings permit the reuse of certain existing materials.

E. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.5 SUBMITTALS

A. All submittals shall be made in accordance with Division 01 requirements.

B. Submit a list identifying the specific type of material that will be used for each piping system. Include pipe, fittings, valves, hangers and supports. Include the designation of the publication applicable for each type of material and method.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Sanitary Drain, Waste and Vent (DWV) Piping:

1. Underground sanitary piping:

a. Service weight hub and spigot pipe and fittings, Fed. Spec. WW-P-401F, ASTM-A74-98, CISPI-301.
b. Charlotte Seal Gaskets, ASTM C-564-97, CISPI-HSN.
c. Warco-Quik-Tite Gaskets, ASTM C-564-94, CISPI-HSN.
d. Schedule 40, PVC-DWV drainage pattern, conforming to the following

standards:

1) ASTM D-1784 – Rigid PVC Vinyl Components.
2) ASTM D-1785 – PVC Plastic Pipe, Schedule 40.
3) ASTM D-2665 – PVC Drain, Waste and Vent Pipe and Fittings.
4) ASTM D-2564 – Solvent Cements for PVC Pipe and Fittings.
5) NSF Standard 14 – Plastic Piping Components and Related Materials.

2. Above-ground sanitary and vent piping:

a. No-hub cast iron pipe and fittings, CISPI Standard 301, ASTM A-888-98el.
b. Service weight hub and spigot pipe and fittings, Fed. Spec. WW-P-401F, ASTM-A74-98, CISPI-301.
c. No-hub couplings, CISPI Standard 310.
d. Charlotte Seal Gaskets, ASTM C-564, CISPI-HSN.
e. Warco-Quik-Tite Gaskets, ASTM C-564-97, CISPI-HSN.
f. Cast iron piping shall provide with 4-band stainless steel fittings.
g. 2” and smaller Type DWV hard-drawn copper tubing, ASTM B-306 with copper drainage pattern and (lead-free) solder 95-5 Tin-antimony.
h. Schedule 40, PVC-DWV drainage pattern, conforming to the following standards:

1) ASTM D-1784 – Rigid PVC Vinyl Components.
2) ASTM D-1785 – PVC Plastic Pipe, Schedule 40.
3) ASTM D-2665 – PVC Drain, Waste and Vent Pipe and Fittings.
4) ASTM D-2564 – Solvent Cements for PVC Pipe and Fittings.
5) NSF Standard 14 – Plastic Piping Components and Related Materials.

3. ½” to 1”: Same as domestic water, Type “L” hard-drawn, or Schedule 40 PVC pipe and solvent joint fittings.
4. PVC Foam core DWV pipe, ASTM F891, is not and shall not be approved under any circumstances nor installed on this project.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Furnish and install piping, fittings and appurtenances required to complete the piping systems shown on the drawings. Elbows shall be long radius type. Tees may not be field fabricated.
2. Run piping to true alignment, generally parallel or perpendicular to building walls, floors and ceilings, and with uniform grades and spacing, so as to present a neat and workmanlike appearance.
3. Care shall be paid to the exact locations of piping with respect to equipment, ducts, conduits, slabs, beams, lighting fixtures, columns, ceiling suspension systems, etc. to provide maximum access to mechanical and electrical equipment in the building. Close coordination and cooperation shall be exercised with other trades in locating the piping in the best interests of the Owner. The drawings and specifications covering other work to be done in the building shall be carefully studied and arrangements made to avoid conflict.
4. Not all necessary pipe offsets are indicated on the drawings because of the small

scale. The various runs of piping to be installed shall be studied and adjustments made in exact routings as may be required for proper installation.

5. Conflicts arising during the erection of piping shall be brought to the attention of the Engineer of Record. No improvising or field changes will be permitted without the approval of the Engineer of Record.
6. Use full lengths of pipe wherever possible. Short lengths of pipe with couplings will not be permitted. Cut to exact measurement and install without forcing or spring unless otherwise shown on the drawings or specified.
7. Avoid tool marks and unnecessary pipe threads. Burrs formed when cutting pipe shall be removed by reaming. Before installing any pipe, care shall be taken that the inside is thoroughly cleaned and free of cuttings and foreign matter. Measures shall be taken to preserve this cleanliness after erection.
8. Arrange pipe connections to valves and specialties so that there is clearance for easy removal of the valve or specialty from the line, and also for the removal of the valve bonnet and interior, and the specialty top and bottom and interior, except where otherwise approved by the Engineer of Record.
9. Erect piping in such a manner so as to obtain sufficient flexibility and to prevent excessive stresses in materials and excessive bending movements at joints or connections to equipment. Make allowances throughout for expansion and contraction of piping. Provide each riser and horizontal run of piping with expansion loops, expansion joints, or expansion compensators where indicated and required. Securely anchor and adequately guide pipe as required or where indicated to force expansion to the expansion device without bending, binding, or misalignment of pipe. Branch connections from mains to risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Where indicated, in lieu of expansion loops, expansion joints, or expansion compensators, horizontal runs of pipe shall be anchored at approximately midway of the run to force expansion, evenly divided, toward the mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining.
10. Installed piping shall not interfere with the operations or accessibility of doors or windows and shall not encroach on aisles, passageways and equipment, and shall not interfere with the servicing or maintenance of any equipment. Adjacent pipelines shall be grouped in the same horizontal or vertical plane.
11. Where lines are purposely pitched for drainage, an accurate grade shall be maintained. No lines shall be supported in such a manner as to permit deflection, due to gravity, sufficient to pocket the lines when full of liquid.
12. Use building steel wherever possible for supporting pipe hangers. Main structural steel shall not be drilled, cut or burned for hangers without the approval of the Structural Engineer of Record. Expansion bolts shall be used only upon the approval of the Structural Engineer of Record.
13. Install unions or flanges in piping connections to equipment, regulating valves, and wherever necessary to facilitate the dismantling of piping and/or removal of valves and other items requiring maintenance.
14. Avoid bushings. Reducing fittings shall be used wherever practical.
15. The drawings indicate the size of piping and connections, and if certain sizes are omitted or unclear, obtain additional information before proceeding.
16. The piping drawings have been worked out with a view to the most economical installation, taking into consideration accessibility and appearances, and the Contractor must follow the drawings accurately and if it is found impractical to install the work in accordance with the drawings and specifications, the Contractor shall notify the Engineer of Record before making any changes and get their approval or revised drawings before proceeding with the work. Verify all measurements on the job before cutting pipes or having piping fabricated, and be responsible for the correct location of all pipe connections, also check sizes and

standard of outlets on the equipment, including the dimensions and drilling of flanges, etc.

17. Change in direction shall be made with fittings, except that bending of copper pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations is not acceptable.
18. Threaded joints shall be made with tapered threads in accordance with ANSI B2.1, and made tight with an approved pipe thread joint compound or material, applied to the male threads only. Use compounds sparingly and apply with caution to ensure that compounds do not enter piping systems. When pipe joint is made up a maximum of 3 threads shall be visible.
19. Joints for plastic pipe shall be made in accordance with PPI Piping Manual.
20. Connections between ferrous and nonferrous metallic pipe shall be made with dielectric unions or flanges.
21. Connections between plastic and metallic pipe, shall be made with transition fittings manufactured for the specific purpose.
22. Unions and flanges shall not be concealed in walls, partitions, or above inaccessible ceilings.

B. Plumbing Systems Additional Requirements:

1. Bends, plugs, or tees in water service lines, except soldered or screwed joints, shall be braced or clamped. The connection between the water service line and the domestic water distribution line shall be anchored by means of tie rods and pipe clamps.
2. Vertical cast iron soil pipe hubs inside buildings shall extend 6 inches above concrete slab-on-grade floors.
3. Provide test tees with screwed plugs in waste and vent systems to isolate sections of system previously tested from section of system under test. Distance between test tees on vertical lines shall not exceed static height allowable for system pressure limitations. All joints in test tees, including plugs, shall be tested under pressure as specified for system tests.
4. Install horizontal drainage piping in uniform alignment at uniform slopes that will produce a computed velocity of not less than 2 feet per second when flowing half full, or a minimum of 1/8" per ft. unless noted otherwise.
5. The underground water service pipe and the building sewer shall be not less than 5 feet apart horizontally, and shall be separated by undisturbed, or compacted, earth, unless the following requirements are satisfied:

    a. The water service pipe and the building sewer may be installed in the same trench, provided written approval is given by the plumbing official and the following conditions are met:

        1) The bottom of the water service pipe at all points shall be not less than 12 inches above the top of the sewer line at its highest point.
        2) The water service pipe shall be placed on a solid shelf excavated at one side of the common trench.
        3) The number of joints in the service pipe shall be kept to a minimum.
        4) The materials and joints in the sewer pipe shall be installed in such manner, and shall possess the necessary strength and durability, to prevent the escape of solids, liquids, and gases there from under all known adverse conditions such as corrosion, strains due to temperature changes, settlements,

vibration, and superimposed loads.

5) Where the water service line must cross the building sewer line, the bottom of the water service line within 5 feet of the point of crossing shall be at least 12 inches above the top of the sewer line. The sewer line shall be of cast iron, with leaded or mechanical joints, within 5 feet of the point of crossing.

6. Provide clean-outs at the base of all sanitary waste and vent stacks.
7. Installation of copper tubing shall be per FPC, ASTM B32-96, and per Copper Development Association and ASTM B828-92-E01.
8. Install plugs or caps on all openings during the construction phase. The temporary plug shall be cap of same material as pipe. Duct tape is unacceptable for use as a plug for the construction phase.
9. All penetrations of piping through walls shall be made insect proof, (i.e., penetrations of waste arms, hot and cold water piping through walls below sinks, lavatories, water closets, etc.). The escutcheon plate does constitute an “insect proof” closure.

C. Plastic Pipe Systems Additional Requirements:

1. Joints between plastic pipe and other materials shall be subject to the following requirements:

   a. Joints between different grades of plastic pipe shall be made by use of an approved adapter fitting.
   b. Joints between the hub of cast-iron soil pipe and plastic pipe shall be made by use of a mechanical joint of the compression or mechanical sealing type.
   c. Joints between plastic pipe and cast-iron pipe, copper tube, and other piping materials shall be made by use of an approved adapter fitting.

2. Plastic pipe, fittings, and solvent cement shall not be used in systems where temperature, and operating pressure plus system static head, exceeds materials temperature and pressure limitations.
3. Plastic piping materials shall not be installed in air plenums, air chambers, or airshafts.
4. Plastic vent piping shall not pass through firewalls, or fire partitions. Plastic waste and vent piping shall be installed in fire rated pipe chases when passing through floors or approved fire stop sleeve.

3.2 BRAZING AND SOLDERING

A. Operator and Procedure Qualifications: All brazing operators and procedures shall be qualified in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

B. Brazing: Silver braze joints in accordance with MSS-SP-73 "Silver Brazing Joints for Wrought and Cast Solder Joint Fittings".

C. Soldering: Joints in copper tubing shall be made with solder- type fittings. Outside surface of the tube where engaged in the fitting, and inside surface of the fitting in contact with the tube, shall be cleaned with an abrasive material before soldering. Self- cleaning compounds shall not be used. Care shall be taken to prevent annealing of tube and fittings when making connections. The solder joint shall be made with flux and wire form solder, except brazed joints. The flux shall be a mildly corrosive liquid or a petroleum based paste containing chlorides of zinc and ammonium. Solder shall be applied and

drawn through the full fitting length. Excess solder shall be wiped from joint before solder hardens. Joints in copper tube sizes 2-1/2 inches and larger shall be made with heat applied uniformly around the entire circumference of the tube and fittings by a multi-flame torch. Use of oxy-acetylene cutting torch in lieu of multi-flame torch is not permitted. Disassemble valves and other accessories that may be damaged by heat before soldering.

3.3 TESTING OF PIPING SYSTEMS:

A. Each piping system, after erection, shall be subjected to a pressure test. The test requirements shall be as follows:

1. General: Furnish everything required for the tests. Notify Architect/Engineer at least 48 hours before any testing is performed. Independent Agent/Owner shall verify pressure test and sign off. Report to be furnished to Architect/Engineer. Testing shall be performed at the completion of each phase of the project.
2. Plumbing related systems shall be tested with water at not less than a 10 foot head. The water shall be kept in the systems for a period of not less than 15 minutes prior to start of visual examination. In lieu of water test, the systems may be tested with air at a uniform pressure of 5 psig, with no loss in pressure for a period of not less than 15 minutes.
3. The building sewer shall be tested by insertion of a test plug at the point of connection with the public sewer, and filled with water under a head of not less than 10 feet, with no drop in water level for a period of not less than 15 minutes.
4. Leaks, if any, shall be located, repaired, and retested in accordance with the test method specified for the system in which the leaks are located.

B. Prior to testing a system, the Contractor shall provide the proper Building Official and the Owner's Representative with not less than 72 hours notice of the proposed test. The Contractor shall obtain approval of the test results. Where written approval is required, the Contractor shall obtain such written approval, and submit a copy of the approval.

C. Work requiring testing shall not be covered, or otherwise concealed, until testing is completed and approval is granted.

D. Work, or portions of work, that is altered in any way after testing and approval shall be retested, witnessed, and approval obtained.

E. Systems requiring hydrostatic tests shall be protected from damage caused by freezing. After tests are completed drain all sections of pipe, including traps, or fill undrained sections and traps with antifreeze solution. Vent all high points to release vacuum and ensure complete drainage of closed systems, and blow out piping with compressed air to remove trapped water.

F. Duration of tests, unless specified otherwise, shall be the time required to examine each joint in the system being tested.

G. Systems requiring hydrostatic testing under pressure shall be vented at high points to ensure that all piping is completely filled with the testing medium.

H. Disconnect pressure boosting apparatus, or vacuum pumps, during the test time span specified for systems employing the pressure loss/time span test method.

I. During tests, isolate system components that have test pressures less than pressures specified for system tests.

J. Use clean soapy water applied to exterior of joints to locate leaks in systems using compressed air, dry carbon dioxide, or nitrogen, under positive pressure as a test medium.

END OF SECTION 22 13 16

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SECTION 22 33 00 - DOMESTIC WATER HEATERS AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following electric water heaters:
   1. Flow-control, instantaneous electric water heaters.
   2. Thermostat-control, instantaneous electric water heaters.
   3. Commercial, storage electric water heaters.
   4. Water heater accessories.

1.2 SUBMITTALS

A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For electric water heaters to include operation, and maintenance manuals.

D. Warranty

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

C. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.

   1. Failures include, but are not limited to, the following:

      a. Structural failures including storage tank and supports.
      b. Faulty operation of controls.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period(s): From date of Substantial Completion:

a. Instantaneous Electric Water Heaters: Three years.

b. Commercial Electric Water Heaters: Three years

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 INSTANTANEOUS ELECTRIC WATER HEATERS

A. Thermostat-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.

1. Manufacturers:

a. Chronomite Laboratories, Inc.
b. Eemax, Inc.

2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.

a. Connections: ASME B1.20.1 pipe thread.
b. Pressure Rating: 150 psig.
c. Heating Element: Resistance heating system.
d. Temperature Control: Thermostat.
e. Safety Control: High-temperature-limit cutoff device or system.
f. Jacket: Aluminum or steel with enameled finish or plastic.

3. Support: Bracket for wall mounting.

2.3 COMMERCIAL ELECTRIC WATER HEATERS

A. Commercial, Storage Electric Water Heaters: Comply with UL 1453 requirements for storage-tank-type water heaters.

1. Manufacturers:
a. Smith, A. O. Water Products Company.
b. State Industries, Inc.
c. Rheem

2. Storage-Tank Construction: ASME-code, steel vertical arrangement.

a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.

1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

b. Pressure Rating: 150 psig
c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

3. Factory-Installed Storage-Tank Appurtenances:

a. Anode Rod: Replaceable magnesium.
b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
c. Insulation: Comply with ASHRAE/IESNA 90.1.
d. Jacket: Steel with enameled finish.

e. Temperature Control: Adjustable thermostat.
f. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
g. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

4. Special Requirements: NSF 5 construction.
5. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.

2.4 WATER HEATER ACCESSORIES

A. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches above the floor.

B. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.

C. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.

D. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1-2004.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. Install commercial water heaters on concrete bases.

1. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.

B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.

E. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

F. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

G. Fill water heaters with water.

3.2 CONNECTIONS

A. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections.

B. Perform the following field tests and inspections:

1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial and instantaneous electric water heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 22 33 00

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SECTION 22 42 00 - PLUMBING FIXTURES AND TRIM

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 WORK INCLUDED

A. The work of this section shall include furnishing all labor and material for complete installation of all plumbing fixtures with fittings, trim, supports and appurtenances as specified herein and shown on the drawings.

1.3 SUBMITTALS

A. Submit shop drawings in accordance with Division 01 Requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The manufacturers or their subsidiaries referenced herein are those that the specifications and drawings are based on. Equipment by other manufacturers will not be considered, no substitutions.

2.2 EQUIPMENT

A. Fixture designations shown on the plumbing drawings are listed below. This list does not limit the quantity of each fixture, as the quantity must be determined by examination of the Plumbing and Architectural drawings.

1. WC-1: Water Closet – Water conserving, white acid resisting, vitreous china, floor mounted, 15” high to top of seat, floor outlet, elongated bowl, 1-1/2" top spud, 1.28 gallon flushometer, siphon jet, white open-front plastic seat and chrome plated diaphragm type flush valve. Coordinate flush valve with grab bar with arch plans prior to piping rough-in. Toilet shall be located to allow grab behind valve body and vacuum breaker tube.

   Fixture: Zurn Z5654-BWL
   American Standard 2856.128

   Seat: Zurn Z5955SS-EL
   American Standard 2599001.020.020

   Flush Valve: Sloan Royal 111-1.28
   Zurn Z6000AV-HET

2. WC-2: Water Closet – ADA/Handicapped - white acid resisting vitreous china, floor mounted, 17” to top of seat, floor outlet, elongated bowl, 1-1/2" top spud, 1.28 gallon flushometer siphon jet, white open-front plastic seat, and chrome plated diaphragm type flush valve with ADA compliant handle. Coordinate flush valve with grab bar with arch plans prior to piping rough-in. Toilet shall be located to allow grab behind valve body and vacuum breaker tube.

Fixture: Zurn Z5665-BWL
American Standard 3043001.020

Seat: Zurn Z5955SS-EL
American Standard 5905.100.020

Flush Valve: Sloan Royal 111-1.28
Zurn Z6000-AV-HET

3. UR-1: Urinal – ADA/Handicapped – 17 inches floor to rim - white acid resisting vitreous china, wall mounted, 3/4" top spud .125 gallon, siphon jet, to floor fixture support and chrome-plated diaphragm type flush valve.

Fixture: Zurn Z5755-U
American Standard 6590001.020

Flush Valve: Zurn Z6003AV-ULF
Sloan Royal 186-0.125

4. UR-2: Urinal – 24 inches floor to rim - white acid resisting vitreous china, wall mounted, 3/4" top spud .125 gallon, siphon jet, to floor fixture support and chrome-plated diaphragm type flush valve.

Fixture: Zurn Z5755-U
American Standard 6590001.020

Flush Valve: Zurn Z6003AV-ULF
Sloan Royal 186-0.125

5. L-1: Lavatory – White acid resisting vitreous china, wall hung, 4" centers, cold water and tempered water, self-closing metering faucet, vandal resistant, 1-1/4" grid drain with 1-1/4" OD tailpiece, chrome plated brass, 1-1/4" "P" trap, with CO plug, chrome plated brass loose-key angle stops with flexible risers and to floor fixture support. Provide vandal proof and lead free faucet and push button assembly**.** Faucet and deck plate must interlock. Provide faucet with a .5 gpm aerator. Coordinate heights with architectural elevations.

Fixture: Zurn Z-5344
American Standard 0355.012

Faucet: T & S Brass B-0831
Chicago Faucets #802-V665ABCP
Zurn Z86500-XL

6. L-2: Lavatory – ADA/Handicapped -White acid resisting vitreous china, wall hung, 4" centers, cold water and tempered water, self-closing metering faucet, vandal resistant, 1-1/4" grid drain with 1-1/4" OD tailpiece, chrome plated brass, 1-1/4" "P" trap, with CO plug, chrome plated brass loose-key angle stops with flexible risers and to floor fixture support. Provide vandal proof and lead free faucet and push button assembly**.** Faucet and deck plate must interlock. Provide faucet with a .5 gpm aerator. Insulate P-trap and supplies in accordance with ADA. Provide faucet with a .5 gpm aerator. Coordinate heights with architectural elevations.

Fixture: Zurn Z-5344
American Standard 0355.012

Faucet: T & S Brass B-0831
Chicago Faucets #802-V665ABCP

Zurn Z86500-XL

7. S-1: Concession Sink – Type 304 18 gauge free standing stainless steel, single bowl, 8” back splash, cold and tempered water, cup strainer and chrome plated cast brass `P' trap with CO plug, chrome plated brass loose key angle stops and chrome plated risers. Provide goose neck faucet, polished chrome-plated cast brass 8” sink faucet with quarter turn ceramic disc cartridge, adjustable centers, centerline swing spout with a 1.5 gpm aerator, with 4” vandal-resistant color-coded metal wrist blade handles.

   Fixture: Eagle 2136-1-16/4

   Faucet: Zurn Z843B4-XL-17F

8. SH-1: Shower – Institutional Compliant - Enclosure by General Contractor. Provide and install chrome pressure balancing institutional shower valve with lever handle, hand held institutional shower head with 1.5 gpm flow restrictor and wall bracket, flexible stainless steel hose with integral vacuum breaker, 2” drain secured with vandal proof screws, with P-trap and trap guard.

   Fitting: Symmons #96-1-X-151 with S-9603-X-PLR-1.5
   Bradley # IC-C5-S1-G-1.5 with volume control/ stops

   Drains: J.R. Smith Fig. 2010-A
   Josam 3000
   Watts FD100-A5

9. SH-2: Shower – ADA and Institutional Compliant - Enclosure by General Contractor. Provide and install chrome pressure balancing institutional shower valve, institutional shower head with 1.5 gpm flow restrictor and wall bracket, 2” drain secured with vandal proof screws, with P-trap and trap guard.

   Fitting: Symmons C-96-1-150-X-VP-CHKS with 4-295-1.5 shower head
   Bradley #IC-C5-B24 with 1C-SX-G-1.5 shower head

   Drains: J.R. Smith Fig. 2010-A
   Josam 3000
   Watts FD100-A5

10. DF-1: Drinking Fountain – ADA/Handicapped Compliance - Single unit, wall hung heavy gauge steel vandal-resistant cabinet. Chrome plated vandal resistant bubbler is heavy duty, one piece construction satin finish stainless steel keyed into position to prevent rotation. Heavy duty push button control is vandal-resistant. In-line flow regulator, rated for indoor or outdoor use, lead free water system. Provide vandal-resistant mounting.

    Fixture: Elkay VRCDS
    Halsey Taylor HVRD-ADA

11. HB-1: (Mechanical) Hose Bibb - 3/4" male hose thread, no lead solder, standard "O" size seat washer, vacuum breaker, loose tee key.

    Fixture: Woodford 24
    MIFAB MHY90
    Zurn Z1341-P34-RC

12. HB-2: (Group Restroom) Hose Bibb - 3/4" male hose thread, no lead solder, standard "O" size seat washer, vacuum breaker, loose tee key. Provide stem lock kit.

Fixture: Woodford 24 w/Stem Lock Sl-24
Zurn Z1341-P34-RC Stem Lock Z1399-HGS

13. WH-1: Hose Bibb – freeze-less, automatic draining, vacuum breaker, cast brass with chrome finish, loose tee key.

Fixture: Woodford Model RB67
Zurn Z1322XL-EZ
Watts HY-725-R
JR Smith 5518-R

14. IMB: Ice Maker Box for refrigerator(s) at all Concessions. Each refrigerator shall have its own ice maker box. Although not noted on the plans, contractor shall supply, install and make connections for the water supply with a shut off valve and water hammer arrestor each icemaker box.

Fixture: Guy Gray BIM875AB
Specialty Products 500T Series

15. MS-1: Janitors Sink - White molded stone, floor mounted, 24" x 24" x 12" faucet with bucket hook with rod support to wall and vacuum breaker. Factory installed drain, mop bracket, hose and rack.

Fixture: Fiat MSBID2424
Zurn 1996-24
Acorn Engineering TRH-242410

Faucet: T&S Brass B665-BSTR
Chicago 897-RCF
Zurn Z843M1-RC

PART 3 - EXECUTION

3.1 FIXTURES

A. All plumbing fixtures and trim shall be new as specified and in accordance with FBC.

B. All plumbing fixtures shall carry a 5 year manufacturer’s warranty.

C. Provide protection of all fixtures during construction from damage. Replace all damaged fixtures as directed by the Architect.

D. Each water supply connection to each fixture and each item of water consuming equipment shall be equipped with an accessible stop valve.

E. All flush valves shall be quiet diaphragm type with integral screwdriver stops, vacuum breakers and have non-hold-open water saving feature. Secure all flush valves to wall with matching stanchions.

F. All wall-hung fixtures shall be supported on carriers designed and fitted to suit the fixture and building construction at each point of application.

G. All exposed bolt heads on water closets and urinals shall be covered with acorns or covers made from china, stainless steel, or chrome plated brass.

H. All plumbing fixtures and equipment shall be provided with all necessary stops, valves, traps, supplies and appurtenances required, except where specifically provided for by another

contract.

I. All handicapped fixtures indicated and shown on the Plumbing and Architectural drawings shall comply with ANSI and FBC.

J. Insulate hot and cold water supply pipes and waste pipe under lavatory per codes.

K. Caulk all gaps between walls/floors and plumbing fixtures.

L. Access panels shall have Allen Key locking latches.

END OF SECTION 22 42 00

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Division 23

Heating, Ventilating and Air Conditioning

SECTION 23 05 10 - BASIC MATERIALS AND METHODS OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Access doors.

B. Electrical requirements.

C. Painting.

D. Concrete work.

E. Fabricated steel supports.

F. Excavation, trenching and backfilling.

G. Placing of equipment.

1.3 RELATED WORK

A. DIVISION 09 - FINISHES (Access Doors - Painting).

B. DIVISION 03 - CONCRETE.

C. DIVISION 31 - EARTHWORK

1.4 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this Section to the extent referenced.

1. American Institute of Steel Construction (AISC) Publications
2. American National Standards Institute (ANSI) Standards
3. American Society for Testing and Materials (ASTM) Publications
4. American Welding Society (AWS) Publications
5. Underwriters Laboratories, Inc. (UL) Standards

1.5 SUBMITTALS

A. Where submittals are required, comply with Division 01 requirements.

B. Shop Drawings: Submit drawings of fabricated steel supports where proposed supports are not in accordance with details on drawings, or where drawings do not detail supports. Submittal for acceptance is required.

C. Product Data: Submittal for other than fabricated steel supports is not required. Product data for the following shall be included in the operation and maintenance manuals. Submittal for acceptance is not required.

1. Access doors.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Access Doors:

1. Acudor
2. Elmodor Manufacturing, Co.
3. Karp Metal Associates, Inc.
4. Larsen’s Manufacturing Co.
5. Milcor

2.2 FABRICATION

A. Access doors:

1. Access doors: UL labeled where installed in fire rated walls, partitions, and ceilings. Door rating shall be not less than wall, partition, or ceiling rating.
2. Frames: 16 gauge steel, flush trim, with corners welded and ground smooth, masonry anchor strap for masonry walls, bolt holes for mounting in framed openings.
3. Non-fire rated doors: 13 gauge steel, concealed continuous piano hinge with dust flap, flush screwdriver operated lock with stainless steel cam and studs.
4. Fire rated doors: 20 gauge steel welded pan type, concealed continuous piano hinge with stainless steel pins, key-operated latch bolt, interior latch release, automatic door closer, automatic door latch when door closes. The door panel shall contain 2- inch thick insulation in sandwich type construction.
5. Finish of doors and frames: Prime coat of rust inhibitive baked enamel, except as specified otherwise.
6. Finish of doors and frames in wet areas, and in areas with surfaces subject to wet cleaning: No. 4 satin stainless steel.

B. Electrical Requirements: Refer to Division 26 specifications.

C. Painting: Product specified in Division 09 - FINISHES.

D. Concrete Work: All work is provided under Division 03 - CONCRETE.

E. Fabricated Steel Supports:

1. Steel angles, channels, and plate shall be in accordance with ASTM A36.
2. Steel members, including fasteners, exposed to weather shall be galvanized.

F. Excavation, Trenching, and Backfilling: Product description not applicable.

G. Placing of Equipment: Product description not applicable.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation of materials and equipment shall be in accordance with the manufacturer's written instructions, except as specified.

3.2 INSTALLATION

A. Access Doors:

1. Furnish access doors for installation under Division 09 - FINISHES.
2. Deliver access doors to the appropriate trade well in advance of the time they are needed so as to avoid unnecessary delay of the work.
3. Access doors shall be sized as indicated on drawings. If no size is given, provide access door of size suitable for servicing equipment or valve. Unless otherwise noted, the minimum size for an access door shall be 12" x 12".
4. Access doors shall be provided where indicated and if not indicated, where required.
5. Access doors shall be installed so as to allow full door swing.
6. Where full swing and access is not possible, removable doors shall be provided.
7. Access doors not required in lay-in-tile ceilings.

B. Electrical Requirements: Refer to Division 26 for electrical requirements.

C. Painting:

1. All equipment shall be furnished with a factory- applied galvanized, prime paint, or finish paint finish. Touch-up damaged surfaces of equipment immediately.
2. Paint for galvanized surfaces shall be in accordance with ASTM A780 using zinc rich compound.
3. Paint wooden mounting backboards with two coats of gray enamel prior to making attachments to the board.
4. For quality control refer to DIVISION 09 - FINISHES.
5. Remove all dirt, rust, scale, grease, pipe dope, solder flux, and welding slag from all surfaces to be painted.
6. Paint immediately, under this Division, all damaged galvanized surfaces. Paint galvanized metal surfaces behind grilles with two coats of flat black paint.
7. Apply rust inhibitive primer to ferrous surfaces of shop fabricated steel supports.
8. Paint immediately under this division all field and shop welded joints in piping or equipment supports with 2 coats of grey metal primer.

D. Concrete Work:

1. Concrete pads and curbs for supports of equipment shall be a minimum of 4" high with chamfered edges and sized for approved equipment. Furnish drawings to CM for Division 03 - CONCRETE to perform.
2. Surfaces of concrete shall be troweled smooth. When forms are removed, fill voids with cement and rub smooth with rubbing stone.
3. Do not pour concrete when ambient temperature is less than 40^{o}F, and falling.

E. Fabricated Steel Supports:

1. Because of the small scale of the drawings, details of equipment support are not always shown. It shall be the responsibility of the contractor to provide supports as required for safe and adequate support.
2. Fabricated steel supports and ladders may be shop or field-fabricated, and shall be in accord with details on drawings.
3. When details are not indicated, the contractor shall submit proposed support detail for review. The contractor shall bear all cost in producing this detail in the bid. This includes but is not limited to structural engineering support.
4. Steel members shall be saw cut, with corners ground smooth, and shall be assembled with welded or bolted connections at Contractor's option. Connections shall be in accord with specified AISC Publications.

F. Excavation, Trenching, and Backfilling:

1. Definitions:

a. Satisfactory material includes all materials except those classified "unsatisfactory", "unyielding" or "unstable".
b. Unsatisfactory material includes those materials containing roots, organic matter, trash, debris, frozen materials, stones larger than 3 inches in any dimension, and materials classified by ASTM D 2487 as OL, OH, and PT.
c. Unyielding material consists of rock and gravely soils with stones greater than 3 inches in any dimension, or as defined by the pipe or tank manufacturer, whichever is smaller.
d. Unstable material consists of material too wet to properly support the pipe or tank.
e. Select granular material consists of well- graded sand, gravel, crushed gravel, crushed stone, or crushed gravel, crushed stone, or crushed slag composed of hard, tough, and durable particles, and shall contain not more than 10 percent by weight of material passing a No. 200 mesh sieve, and no less than 95 percent by weight passing the 1 inch sieve. The maximum allowable aggregate size shall be 3 inches, or the maximum size recommended by the pipe or tank manufacturer, whichever is smaller.

2. Excavation, trenching, and backfilling for site utility piping systems as specified in DIVISION 31 - EARTHWORK.

G. Placing of Equipment:

1. Coordinate setting of equipment with the requirements of other trades so as to avoid conflicts and to insure compatibility. Equipment shall not block access for installation of other equipment.
2. All air-handling units shall have a minimum clearance as shown on the drawings and per the manufacturer’s recommendations. If this can not be accomplished on any mechanical room this shall be brought to the attention of the engineer prior to bid or during the submission of a substitution request.
3. Set base mounted equipment on permanent and finished supports. Temporary support, if any, shall be removed prior to making final pipe, duct, or electrical connections to equipment.
4. Adjust suspended equipment to final elevation prior to making pipe, duct or electrical connections.
5. Exercise caution during equipment placing operations to insure that structure is not overloaded.
6. Do not move heavy equipment across floor or roof of insufficient load bearing capacity to support such equipment. Provide bracing or shoring as required, or use crane to place equipment directly on permanent and finished support.
7. Secure all roof mounted equipment to the structure adequately to resist overturning, uplift and sliding forces for basic wind speeds indicated for this location in Figure 1609B of the Florida Building Code, 5th Edition (2014).
8. Guards shall be provided where appliances, equipment, fans or other components that require service are located within 10 feet of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches above the floor, roof or grade below. The guard shall extend not less than 30 inches beyond each end of such appliance, equipment, fan or component and the top of the guard shall be located not less than 42 inches above the elevated surface adjacent to the guard. The guard shall be constructed so as to prevent the passage of a 21-inch-

diameter sphere and shall comply with the loading requirements for guards specified in the Florida Building Code, 5th Edition (2014).

END OF SECTION 23 05 10

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SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

C. Refer to Division 26 – Electrical.

1.2 WORK INCLUDED

A. Starters for all motors furnished under this Division, except where starters are provided in a motor control center by Electrical Specifications or where motors require adjustable frequency drives.

B. Motors for equipment furnished under this Section.

1.3 SUBMITTALS

A. Motor Starters:

1. Submission for acceptance is not required. Provide a schedule indicating duty, motor HP, starter size and heater size.
2. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

B. Motors:

1. Submission for acceptance is required. All three phase motors are based on NEMA Premium™ efficiency motors as described below by the minimum allowable efficiency. As a result, all motor starting codes are based on Code letter F or greater as defined by NEC Article 430, Table 430-152. In the event that a manufacturer provides a motor with a code letter less than F, the overcurrent protection of the motor shall be coordinated with the Electrical Contractor to comply with NEC Article 430.
2. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

1.4 APPLICABLE PUBLICATIONS

A. NEMA Publication ICS.

B. NEMA Publications MG-1, MG-2, MG-13.

1.5 QUALITY ASSURANCE

A. All starters to be standard product of single manufacturer.

B. Motor efficiencies in accordance with IEE Standard 112 Method B as defined by NEMA MG1-1.23 a. and b.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Starters:

1. Allen Bradley
2. Cutler Hammer
3. General Electric
4. Square D

B. Motors:

1. A.O. Smith/Century E-Plus
2. Baldor Electric Company, Premium Efficiency.
3. Emerson Electric Company, U.S. Electrical Motors Div., Premium Efficiency Type ‘DE’ & ‘RE’.
4. The Louis Allis Company, High Efficiency.
5. General Electric Company, Premium Efficiency Energy Saver®
6. Reliance Electric Manufacturing Company, XE™ Premium Efficiency Motors.

2.2 FABRICATION – MOTOR STARTERS

A. Starters - Full Voltage, Single Speed, Magnetic:

1. Full voltage, non-reversing magnetic as scheduled.
2. 3 phase, 60 Hz, voltage as scheduled.
3. Electronic overload relay protection in all phases.
4. Manual reset in cover.
5. Under voltage release.
6. Hand-off-automatic selector switch.
7. Red and green panel lights that are multi-LED style. Full voltage lamps are not acceptable.
8. Size to suit motor being controlled.
9. Control transformer for 120 volt control, fused and grounded in accordance with NEC.
10. Non-fused disconnect switch.
11. Starters located indoors to have NEMA 1 General Purpose Enclosure. Starters located outdoors or in unheated spaces to have NEMA 3R watertight and dust tight enclosure.
12. Solderless lugs.
13. Two N.O. auxiliary contacts.
14. Starter for all motors shall include three-phase power monitor as manufactured by Time Mark Corporation Model 258 or equal, providing solid state protection by opening starter for loss of any phase, low voltage of any or all phases, and phase reversal. Monitor shall be field adjustable for drop-out voltage. Monitor shall be UL recognized.

B. Manual Starters:

1. Bi-metal type thermal overload protection in all phases of type to cause switch handle to assume mid position on overload.
2. Quick break operating mechanism and silver contacts.
3. Pressure type terminals.
4. Mechanism trip free so contacts cannot be reclosed until bimetallic strip cools.
5. Starters located indoors to have NEMA 1 General Purpose Enclosure. Starters located outdoors or in unheated spaces to have NEMA 3R watertight and dust tight enclosure.
6. Manual starters for three phase motors shall utilize a full voltage single speed,

magnetic starter. A toggle switch shall be provided to facilitate the manual control specified of the magnetic starter.

2.3 FABRICATION – MOTORS

A. 3/4 HP and Larger Horsepower Motors:

1. NEMA Premium™ efficiency type having the following minimum efficiencies:

Minimum Nominal Full-Load Motor Efficiency (%)						
	Open Motors			Totally Enclosed		
Number of Poles	2-Pole	4-Pole	6-Pole	2-Pole	4-Pole	6-Pole
Speed (RPM)	3600 RPM	1800 RPM	1200 RPM	3600 RPM	1800 RPM	1200 RPM
HP						
0.75	---	85.5	---	---	85.5	---
1	82.5	85.5	82.5	77.0	85.5	82.5
1.5	84	86.5	86.5	84.0	86.5	87.5
2	85.5	86.5	87.5	85.5	86.5	88.5
3	85.5	89.5	88.5	86.5	89.5	89.5
5	86.5	89.5	89.5	88.5	89.5	89.5
7.5	88.5	91	90.2	89.5	91.7	91.0
10	89.5	91.7	91.7	90.2	91.7	91.0
15	90.2	93	91.7	91.0	92.4	91.7
20	91	93	92.4	91.0	93.0	91.7
25	91.7	93.6	93	91.7	93.6	93.0
30	91.7	94.1	93.6	91.7	93.6	93.0
40	92.4	94.1	94.1	92.4	94.1	94.1
50	93	94.7	94.1	93.0	94.5	94.1

2. Drip proof, except motors located outdoors to be TEFC or as otherwise specified.
3. Continuous duty, 40°C ambient.
4. Re-greasable ball bearing design.
5. Speed/Torque curves shall be NEMA Design B so that overload protection provided by standard motor starters will be adequate to prevent over-heating during stall or slightly prolonged motor acceleration.
6. Class B insulation, except motors for variable speed drive application to be specially built for Adjustable Frequency Drive (AFD) duty and include Class F insulation and be suitable for operation down to 10% on fan and pump applications.
7. Provide shaft grounding protection on all motors driven by VFDs.
8. Assembly to meet application.
9. 1.15 service factor.
10. Suitable for starter type as scheduled on drawings.
11. Slide bases as required.
12. 60 Hz. terminal box large enough to accommodate the required conduit and wiring.
13. 200, 208, 230 or 460 volt, 3 phase as scheduled.

B. Fractional Horsepower Motors:

1. Permanent split capacitor.
2. 115 volt, 1 phase, 60 Hz.
3. Thermally protected.
4. Other features of motors supplied as an integral part of a factory assembly shall be acceptable as the manufacturer’s standard based on acceptance of the assembly as a whole.

PART 3 - EXECUTION

3.1 GENERAL

A. Furnish starters for all motors furnished under Division 23 except where starters are provided in motor control center by Division 26.

B. Receive, unload and deliver starters to electrical contractor on job-site for storage, uncrating and installation by Division 26.

C. Furnish all necessary wiring diagrams to Division 26 for installation and power wiring.

D. Starter Schedule:

1. All motors up to and including 40 HP at 460 V or 20 HP at 200V shall be provided with full voltage starters.
2. Single phase motors requiring automatic start-stop to be provided with manual starter and controlled by pilot relay.
3. Pump and fan motors listed as adjustable or variable speed to be controlled by adjustable frequency drive units specified in Section 23 05 17.
4. All three phase motors shall be provided with phase loss protection.

E. Starters to be mounted where indicated on the drawings or within sight of the motor controlled.

F. Starters may be mounted directly to masonry, CMU or concrete walls using appropriate fastening methods. When the wall is an exterior wall or any wall where condensation may occur, provide appropriate stand-off, i.e., Unistrut channel).

G. Starters may be mounted directly to equipment such as factory or field built AHU. In this case, through bolts and backing plates along with an appropriate stand-off shall be used. Seal all holes. Self-tapping screws with exposed ends will not be acceptable.

H. When starters are required to be located in areas where walls are not available, provide a Unistrut type frame securely mounted to floor adequately braced to form a rigid mounting surface.

I. Starters shall be generally mounted with the center of the unit at 60" above the finished floor. Service clearance shall be provided in accordance with the National Electric Code and under no circumstances less than the following:

Voltage to Ground	Minimum Clearance Distance
110V or 120V	3'-0"
208V, 220V, 240V or 277V	3'-6"
460V or 480V	4'-0"
Greater than 480V	5'-0"

J. Starters shall be accessible.

K. Provide housekeeping pad for all floor mounted starters.

3.2 MOTORS – INSTALLATION

A. Motors:

1. Install in accordance with requirements of the duty.
2. Lugs to be provided under this Division.
3. All motors shall have overload protection as required by NEC. Any motor without integral protection shall have a starter that provides overload protection furnished by Division 23.

END OF SECTION 23 05 13

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SECTION 23 05 17 - ADJUSTABLE FREQUENCY DRIVES

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 WORK INCLUDED

A. Adjustable frequency drive units (AFD) for all motors identified as operating at variable speed.

1.3 QUALITY ASSURANCE

A. All adjustable frequency drives and bypass assemblies and control panel enclosures must be the product of a single manufacturer.

B. AFD shall be UL or ETL listed. Components used in all options shall be UL listed. The entire AFD and bypass assembly shall be U.L. marked with a short circuit current rating of at least 100,000 amperes. The VFD short circuit rating shall be posted in the operating instructions or on the product label. This shall be in compliance with the UL listing and rating requirement.

C. The AFD shall be designed to meet the power line transient conditions defined within ANSI/IEEE C62.41-2002 “Guide on the Surge Environment in Low-Voltage (1,000 V and less) AC Power Circuits” and shall have a voltage withstand rating of 6 KV in accordance with UL 1449.

D. AFD shall be in certified for with FCC emission limits for Class A computing devices. If required to meet these limits, isolation transformers, and/or line filters shall be provided.

E. Ambient noise generated by the AFD shall be limited to an amount equal to 3 dbA greater than the fan or pump system noise level at design rpm. If acoustic enclosures are required to meet these limitations provide same with the AFD.

F. AFD manufacturer shall submit an analysis to certify that the drive, when installed in the electrical distribution system shown on the Contract Documents is in compliance with the requirements of IEEE 519-2014. The Point of Common Coupling (PCC) shall be defined as the secondary lugs of the Utility Company Transformer. The transformer impedance shall be 5.75% with the appropriate short circuit current based on this value.

G. AFD and option design and construction thereof shall comply with all applicable provisions of the latest National Electrical Code.

H. Power components shall undergo burn in to ensure product function. Circuit boards shall be tested under thermal cycling and the complete unit shall be tested under full load conditions to ensure maximum product reliability.

I. A Factory Authorized Service Engineer is to be provided for start up which shall include verification of proper installation and wiring. Inspect all components, circuit boards and control wiring. Ensure proper power source and control signal. Apply power and provide full operational testing and calibration. Also provide a minimum of 16 hours training for owner's operators.

J. Provide full three year on-site parts and labor warranty including travel time and expense. Warranty period shall begin at date of AFD shipment.

K. The supplier shall offer a service support group which shall be able to provide the following additional services; not included in this contract:

1. Emergency service calls.
2. Overnight service parts.
3. Service contracts.
4. In-plant training of client personnel in basic troubleshooting.
5. Coordinate enrollment of client personnel in factory-held service schools.

1.4 SUBMITTALS

A. Submission for acceptance is required. Submittal shall show compliance with all paragraphs and statements listed in Part 2 below.

B. A complete harmonic analysis showing compliance with IEEE 519-2014 shall be provided with the submittal as defined in paragraph 1.3 above.

C. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

D. Submit in accordance with Division 01 Requirements.

1.5 WARRANTY

A. Provide a full parts & labor warranty for 36 months from ship date.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Adjustable Frequency Drive Units:

1. ASEA Brown Bovari (ABB)
2. Century (MagnaTek)
3. Cutler Hammer
4. Danfoss/Graham
5. Square D
6. Trane

2.2 EQUIPMENT REQUIREMENTS

A. Adjustable Frequency Drive:

1. The adjustable frequency drive shall convert either 208/230 or 460 volt ±10%, three phase, 60 HZ (± 2 HZ) utility power to adjustable voltage/frequency, three phase, AC power for stepless motor control from 5% to 105% of base speed.
2. The adjustable frequency drive (AFD) shall produce an adjustable AC voltage/frequency output for complete motor speed control using transistorized sinecoded PWM technology, and an input power factor near unity over the entire speed range. The AFD shall not produce excessive or objectionable motor acoustical noise. The AFD shall not induce voltage line notching back to the utility line and total harmonic distortion (THD) shall not exceed the limits set in

IEEE Std. 519 -2014 when installed in the electrical distribution system shown on the Contract Documents. The AFD shall be automatically controlled by a grounded electronic control signal.

3. Provide shaft grounding protection on all motors driven by VFDs.
4. The AFD shall be self contained, totally enclosed in a NEMA 1 ventilated cabinet and capable of operation between 0° and 40°C except where located outdoors enclosure to be NEMA 3R or 4X watertight and dust-tight enclosure, depending on the manufacturers offering. The entire AFD assembly shall be mounted in a common enclosure requiring only a power in and a power out connection.
5. The AFD maximum output current rating shall be as follows:

Horsepower (HP)	FLA @ 208 V	FLA @ 460 V
5	16.7	8.2
7-1/2	24.2	11.0
10	28.0	14.5
15	46.2	21.0
20	59.4	27.0
25	----	34.0
30	----	40.0
40	----	52.0
50	----	65.0
60	----	77.0
75	----	106.0
100	----	130.0

6. AFD shall be a minimum of 97% efficient at 100% rated output power, 60 HZ.
7. The AFD shall have the following basic features:

   a. Operator control interface.

      (1) Hand/Off/Auto operator switch.
      (2) Panel mounted digital display capable of indicating unit status, frequency and fault diagnostics, including overcurrent, overvoltage, overheating, ground fault or short circuit.

   b. Electronic control follower board, 0-5 VDC, 0-10 VDC or 4-20 mA or 0-135 ohms (coordinate requirement with controls contractor).
   c. Minimum/maximum adjustable speeds (Minimum speed factory set at 12 HZ, maximum speed factory set at 60 HZ, may vary based on application).
   d. Manual speed potentiometer control for use when AFD is in manual control mode.
   e. Adjustable linear timed acceleration and deceleration for soft starting/stopping (adjustable from 1-300 sec) recommended range 20-60 seconds depending on inertial load. Factory set at 60 seconds.
   f. 3-80 HZ controlled speed range (factory set at maximum frequency of 60 HZ).
   g. Output terminals for remote frequency meter and ammeter.
   h. RFI/EMI filter.
   i. Manual bypass circuit with three contactors to provide full speed starter operation for motors 100 HP and less and an electronic, solid state, full-wave, soft-start controller for all motors 125 HP and larger for operation in the event of AFD electronics failure complete with disconnect and overload protection in all three phases. Provide a three-phase power monitor as manufactured by Time Mark Corporation Model 258 or equal,

providing solid state protection by opening starter for loss of any phase, low voltage or any or all phases, and phase reversal. Monitor shall be field adjustable for drop-out voltage. Monitor shall be UL recognized.

j. Line circuit breaker disconnect (door-interlocked) with current limiting fuses on the line side of the circuit breaker having a minimum AIC rating of 200,000 Amps. The disconnect switch shall have a minimum short circuit rating of 100,000 amps.

k. Provide line impedance reactors to the power line to reduce the total harmonic distortion (THD) level to that allowed by IEEE 519-2014. If the harmonic distortion level required by IEEE 519-2014 can be met without these devices, they may be omitted.

l. Isolation transformer with electrostatic shields for optimum noise protection and phase shifting capability shall be provided where the addition of line impedance reactors will not lower the total harmonic distortion (THD) level to that allowed by IEEE 519-2014. If the harmonic distortion level required by IEEE 519-2014 can be met with only line reactors, then phase shifting isolation transformers may be omitted.

8. The AFD controller shall include the following protective circuits/features:

a. Current limit shall be provided at 100% of the motor FLA. If current exceeds 100% of the motor current, the AFD will slow down the motor. If the current continues to rise the AFD shall shutdown on overcurrent. Current limit will be adjustable by qualified service personnel for application of AFD to smaller than nameplate motors.

b. Current limit/soft stall feature - current limit/soft stall allows continuous operation while in an overload condition. It limits the current by slowing down the frequency. The soft stall feature will be field set and the current limit adjusted to 100% of the motor FLA or drive FLA whichever is smaller.

c. Instantaneous electronic trip - automatically safely shutdown motor if:

(1) Current exceeds 200% of design.
(2) Phase-to-phase output short circuit occurs.
(3) Phase-to-ground output short circuit occurs.
(4) Phase loss occurs.

d. The AFD shall be programmable to provide restart automatically, if desired, when input line returns to normal in the event of:

(1) Intermittent power outage.
(2) Phase loss.
(3) Overvoltage shutdown.
(4) Intermittent voltage spike.

e. Insensitive to incoming power phase.

f. Line-to-line fault protection.

g. Line-to-ground short-circuiting and accidental motor grounding protection.

h. Electronic overload protection.

i. Over-temperature protection.

9. The AFD shall be designed and constructed to operate within the following service conditions:

a. Elevation up to 3300 feet without derating.

b. Ambient temperature range - 0°C to 40°C.
c. Atmosphere - non-condensing relative humidity to 90%.

d. A-C line voltage variation - 10% to +10%.
e. A-C line frequency variation ± 2 HZ.

10. Bases of Design: Danfoss FC102 or Trane TR200.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Adjustable Frequency Drive:

1. Furnish adjustable frequency drive for each motor identified as requiring an adjustable frequency drive or variable speed operation.
2. Receive, unload and deliver drives to electrical contractor on job-site for storage, uncrating and installation by Division 26.
3. Furnish all necessary wiring diagrams to electrical contractor for installation and power wiring.
4. Coordinate the purchased equipment with the motor served and with the automatic temperature control system, paying specific attention to the signal sent and received and the ground source.
5. Start-up shall be by a factory trained field service engineer. Start-up shall be done with the cooperation of the controls contractor. The minimum speed shall be set for 20% at the AFD. The control signal shall be full scale so that the minimum speed will be 20% (adjustable).
6. AFD to be mounted where indicated on the drawings or within sight of the motor controlled.
7. Where a remote disconnect is provided for a motor controlled by an adjustable frequency drive, coordinate with the supplier of the disconnects to ensure that a late make, early break auxiliary contact rated for ten amps continuous duty is provided on the disconnect. This auxiliary contact must be wired into the AFD start circuit to ensure shut-down of the AFD in the event of the remote disconnect being opened.
8. AFD may be mounted directly to masonry, CMU or concrete walls using appropriate fastening methods, including back plates. When the wall is an exterior wall or any wall where condensation may occur, provide appropriate stand-off, i.e., Unistrut channel).
9. AFD may be mounted directly to equipment such as factory or field built AHU. In this case, through bolts and backing plates along with an appropriate stand-off shall be used. Seal all holes. Self-tapping screws with exposed ends will not be acceptable.
10. When AFD is required to be located in areas where walls are not available, provide a Unistrut type frame securely mounted to floor adequately braced to form a rigid mounting surface.
11. AFD shall be generally mounted with the center of the unit at 60" above the finished floor. Service clearance shall be provided in accordance with the latest edition of the National Electric Code and under no circumstances less than the following:

Voltage to Ground	Minimum Clearance Distance
110V or 120V	3'-0"
208V, 220V, 240V or 277V	3'-6"
460V or 480V	4'-0"

Greater than 480V	5'-0"

12. Adjustable frequency drives shall be accessible.
13. Provide housekeeping pad for all floor mounted adjustable frequency drives.
14. Provide construction phase dust protection for all AFDs.

END OF SECTION 23 05 17

SECTION 23 05 18 - CONTROL WIRING

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. Refer to Division 26 for electrical wiring requirements.

C. Refer to Specification Section 23 09 23 – Instrumentation and Control Devices for HVAC

1.2 WORK INCLUDED

A. Building Control System Wiring – Specification Section 23 09 23.

B. Water Treatment Equipment Interlock Wiring.

C. Interior & Exterior Lighting Control Wiring

1.3 DEFINITIONS

A. Control Wiring: All wiring, high or low voltage other than power wiring, required for the proper operation of the mechanical systems.

B. Power Wiring: All line voltage wiring to the mechanical equipment. Line voltage which also serves as a control circuit, such as a line voltage thermostat, or involves interlocking with a damper, shall be considered control wiring.

1.4 QUALITY ASSURANCE

A. All work will be in accordance with the requirements of the National Electrical Code.

1.5 SUBMITTALS

A. Submittals are not required.

PART 2 – PRODUCTS

2.1 MATERIALS

A. All material used in the completion of the wiring under this section will comply with the requirements of Division 26 Electrical and Section 23 09 23 – Instrumentation and Control Devices for HVAC.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Cooperate completely with the contractor for Division 26.

B. Provide all conduit, wire and accessories necessary to complete the control wiring as specified under WORK INCLUDED.

C. Because of variations in requirements from manufacturer to manufacturer, all details may

not be included in the Contract Documents. This sub-contractor must obtain approved coordinated wiring diagrams before proceeding with the control wiring.

D. All control wiring shall be properly installed in an approved raceway system or when allowed, run exposed in concealed spaces. All control wiring run in exposed areas shall be in an approved raceway unless otherwise noted.

E. Control wire run exposed shall be neatly bundled and routed parallel and/or perpendicular to building structure or equipment casing. Routing of wire shall be so that it does not interfere, chafe or obstruct service or maintenance of the equipment served.

F. Exposed control wire shall be properly secured and/or supported within equipment encloses. Cable shall be secured on no greater than 18" centers.

G. All openings made for the passing of control wire shall be properly bushed to prevent chafing. The size of the hole shall be suitable for the quantity of wires or tubing passing through while allowing for ease of pulling and future expansion. Oversized holes beyond these requirements are not allowed.

H. Holes made within air handling equipment which may allow the transfer or bypassing of air shall be properly sealed after wire is pulled. Expanding foam sealant and proper backing material will be acceptable. Seal shall be suitable for maximum unit operating pressures.

I. Attachments of control devices, raceway and cable supports shall be made with proper attachments. Self-drilling screws which result in exposed end will not be acceptable. Bolts and nuts shall be used with bolt head exposed to view. All fasteners located where exposed to weather or moisture shall be stainless steel or cadmium plated.

J. Any opening, holes or cuts in equipment enclosures or building structure not used shall be neatly sealed. On equipment, the seal or patch shall be of similar material sealed and painted to match.

K. The control contractor shall clean all unused or scrap material from the equipment enclosure.

L. All control wire shall be identified by proper cable identification methods. Verify how cables shall be labeled with the Owner's Representative prior to the start of work. All termination shall be labeled and labels clearly visible.

M. All control devices, cabinets, equipment and raceways shall be labeled. Verify how the hardware shall be labeled with the Owner's Representative prior to the start of work.

N. Splices in control wire are not allowed unless the length of run is too great to allow for a continuous run. When splices become necessary, they shall be solder connected with heat shrink tubing. When raceway is used, all splices shall be in junction boxes.

O. Control devices (i.e., flow switches), connected to cold equipment where the possibility of condensation may occur shall be vapor-proof type. The connecting conduit shall be properly sealed with spray type foam after the wires are pulled through. If this is not possible, a weatherproof junction box shall be close mounted to the device to allow for proper moisture sealing. Conduit connections shall be sealed with a silicon type caulk/sealant.

P. All control devices or wiring located exposed to weather or moisture shall be in an approved raceway system. This system shall be properly supported and sealed to

prohibit moisture convection or transfer. Provide flexible conduit similar to seal tight for connection to all equipment. EMT and set screw fittings are not acceptable. All exterior raceway shall be IMC (Intermediate Metallic Conduit) or better with threaded fittings.

Q. Where a disconnect switch is mounted between an adjustable frequency drive and the motor, the disconnect switch must have a late make, early break auxiliary contact. This contact shall be wired into the AFD control circuit so that the control circuit is disconnected before the power circuit it broken.

R. BCS Contractor to fully review the electrical drawings for interlock wiring required for exterior and interior lighting control. BCS contractor to coordinate with the electrical contractor all relays, contactors, programming and wiring required.

S. BCS Contractor to fully coordinate with all other trades to ensure sufficient service access to HVAC control panels and devices.

END OF SECTION 23 05 18

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SECTION 23 05 19 - METERS, GAGES AND ACCESSORIES FOR HVAC 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 WORK INCLUDED

A. Strainers.

B. Thermometers and Accessories.

C. Pressure Gauges and Accessories.

D. Pressure and Temperature Test Ports.

E. Pressure and Temperature Test Kit.

F. Pump Suction Diffuser.

G. Install Miscellaneous Control Devices.

1.3 SUBMITTALS

A. Submit schedule of all products used. Include make, model and size. When multiple products will be used, generic size and flow range will be acceptable.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Strainers:

1. American Wheatley
2. Crane
3. ITT Grinnell
4. O.C. Keckley
5. Mueller Steam Specialty Co. (MUESSCO).
6. RP&C Division, Conbraco Industries, Inc.
7. Victaulic (for all grooved end strainers)

B. Thermometers and Accessories:

1. Duro Instrument Corp.
2. Taylor
3. H.O. Trerice
4. Weiss
5. Weksler
6. Winter’s ThermoGauges

C. Pressure Gauges and Accessories:

1. Ashcroft
2. Duro Instrument Corp.
3. H.O. Trerice
4. Weiss
5. Weksler
6. Winter’s Thermogauges

D. Pressure and Temperature Test Ports:

1. Peterson Equipment Co., Inc.
2. Sisco P/T Plugs
3. Owner approved substitution

E. Pressure and Temperature Test Kit:

1. Peterson Equipment Co., Inc.
2. Sisco P/T Plugs
3. Owner approved substitution

F. Pump Suction Diffuser:

1. American Wheatley
2. Armstrong Pump Co.
3. Bell and Gossett
4. Mueller Steam Specialty Co (MUESSCO).
5. Taco, Inc.
6. Victaulic (for all grooved end suction diffusers)

2.2 FABRICATION

A. Strainers:

1. "Y" Pattern:

a. HVAC Water Service:

(1) Size 1/4" thru 2": Cast iron body, threaded connection, threaded blow-off cover, removable stainless steel screen .045" perforations, rated at 450 PSIG. Based on Mueller Steam Specialty Co. (MUESSCO) #11M.

(2) Size 2-1/2" and up: Cast iron body, flanged connection, flanged blow-off cover. Blow-off cover tapped for blow-off valve, removable stainless steel screen .045" perforations, rated at 125 PSIGG. If grooved mechanical system is in use a "T" type grooved end, ductile iron body, available with blow off, 304 SS removable screen, choice of mesh size.

b. Grooved End “Y” Pattern

(1) 2”(DN50) through 18”(DN450) sizes, 300 PSI (2065 kPa) Y-Type Strainer shall consist of ductile iron body, ASTM A-536, Grade 65-45-12, Type 304 stainless steel perforated metal removable baskets with 1/16" (1,6mm) diameter perforations 2"-3" (DN50-DN75) strainer sizes, 1/8" (3,2mm) diameter perforations 4"-12"

(DN100-DN300) strainer sizes, and 0.156” (4mm) diameter perforations 14” -18” (DN350-DN450) strainer sizes. Victaulic Style 732 and W732.

2. Basket Strainer:

a. HVAC Water Service:

(1) Size 4" and up: Cast iron body, flanged connection, flanged cover, cover tapped for air vent, body tapped for drain valve, removable stainless steel basket .125" perforations rated at 150 PSIG. Based on Mueller Steam Specialty Co. (MUESSCO) #165.

B. Thermometers and Accessories:

1. Industrial Reading Non-Mercury Type:

a. Construction: Adjust angle, 9" scale with lagging extension brass well, of the blue dye (only) fill type and guaranteed accurate to ± one scale division. Thermometer shall have glass front to exclude dirt and dust. Thermometers containing mercury are not acceptable. Thermometers installed outdoors shall be specifically designed and weatherproofed for this application.

b. Stem Length:

(1)	6" pipe and smaller	3-1/2"
(2)	8" to 12" pipe	6"
(3)	For storage tanks	9"

c. Ranges:

(1)	Chilled water	0 to 120°F

d. Based on Weksler Type EG5H-9

2. Bi-Metal Dial Type:

a. Construction: 5" dial, adjust-angle, with lagging brass extension well. Stainless steel case bezel, fittings and stem. Head assembly sealed against dust, fumes and moisture with glass window. Accuracy of ± 1% of thermometer range and also be externally adjustable.

b. Stem Length:

(1)	6" pipe and under	2-1/2"
(2)	8" to 12" pipe	4-1/2"
(3)	For storage tanks	7-1/2"

c. Range:

(1)	Chilled water	0 to 150°F

d. Based on Weksler Type AF.

3. Thermometer Well: Construction - Brass or ductile iron body, with lagging extension, length to accommodate thermometer stem length. Based on Weksler.

C. Pressure Gauges and Accessories:

1. Pressure Gauges:

a. Construction: 4-1/2" dial, high impact polypropylene case, 1/4" bottom connection, 1/2% accuracy in accordance with ANSI B40.1 - 1974 Grade A. Stainless steel rotary with stainless steel pinion gear; stainless steel sector gear; stainless steel link. Stainless steel bourdon tube, 316 stainless steel socket and slotted adjustable pointer.
b. Case of black high impact polypropylene suitable for surface or direct mounting and with bottom connection. For outdoor locations, provide glycerine filled gauges.
c. Range: Ranges shall be so selected to indicate pressure reading in midpoint of scale selected.
d. Based on Weksler Model AA44-2 and AY44-2.

2. Manifold Valves (Trumpet Valve) (Water):

a. 2, 3 or 4 port. Brass body, spring return, push button brass valves, 1/4" compression connections. Gauge tap at top, calibrated gauge test port with gauge cock. 125 PSIG rated, 20°F to 220°F range. Based on Flow Conditioning Corporation Hydronic Indicator System.

3. Piston type snubber: Brass body, threaded connections, suitable for mounting horizontal or vertical. (Required at pump inlet and discharge.) Based on Weksler Type RS-1.
4. Filter type snubber: Brass body, threaded connection, micro metallic stainless steel filter. (For all gauges except pump service). Based on Weksler Type BW42.
5. Siphon: Iron, straight or right angle rated at 500 PSIG steam. (For steam and high temperature hot water systems). Based on Weksler A03I.

D. Pressure and Temperature Test Ports:

1. Brass or stainless steel body with threaded cap and gasket, length to extend past insulation.
2. Two self closing valves with intermediate pocket for added pressure protection. Sized for standard 1/8" probe.
3. Supply these ports upstream and downstream of any strainer.
4. Range: 20°F to 230°F.
5. Rating: 250 PSIG water.
5. Based on Peterson Equipment Co., Inc. "Pete's Plug" Model 110 or 110XL.

E. Pressure and Temperature Test Kit:

1. Pressure-temperature test kits consisting of 0-100 PSIG pressure gauge with adapter, 25-125°F testing thermometer, 0-220°F testing thermometer, gauge adopted and protective carrying cast and master air vent assembly.
2. Provide 2 kits.
3. Based on Peterson Equipment Co., Inc., Series 1500 Test Kit.

F. Pump Suction Diffuser:

1. End Suction Diffuser:

a. Construction: Cast iron angle type body with inlet vanes and combination

diffuser-strainer-orifice cylinder with 3/16" diameter openings for pump protection flanged connection. A permanent magnet shall be located within the flow stream and shall be removable for cleaning. The orifice cylinder shall be equipped with a disposable fine mesh strainer, which shall be removed after system start-up. Orifice cylinder shall be designed to withstand pressure differential equal to pump shutoff head and shall have a free area equal to five times cross section area of pump suction opening. Vane length shall be no less than 2-1/2 times the pump connection diameter. Unit shall be provided with adjustable support foot to carry weight of suction piping. Body tapped for pressure gauge and strainer blow-down.

b. Size: Inlet system pipe. Outlet pump suction size. When an inlet size pipe size by pump suction size diffuser is not available, provide an inlet size by size nearest to pump suction and a flanged eccentric reducer from pump suction diffuser outlet size to pump suction size.

c. Based on Bell and Gossett.

2. Grooved End Suction Diffuser:

a. Construction: Angle pattern, 175-psig (1204-kPa) pressure rating, cast-iron body and end cap, pump-inlet fitting; with stainless-steel or bronze 20-mesh startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support or integrally cast base support boss. Basis of Design: Victaulic 731-Series.

b. Size: Inlet system pipe. Outlet pump suction size. When an inlet size pipe size by pump suction size diffuser is not available, provide an inlet size by size nearest to pump suction and a flanged eccentric reducer from pump suction diffuser outlet size to pump suction size.

PART 3 - EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturers written installation instructions.

B. Provide sufficient service/maintenance access and clearances to facilitate strainer basket removal and cleaning without having to remove any other devices or equipment. This applies to all items listed in the section of the specification.

3.2 INSTALLATION

A. Strainers:

1. "Y" Patterns:

a. All “Y” pattern strainers shall be installed with the strainer branch in the downward vertical position.

b. For all “Y” pattern strainers, provide blow-off valve assembly consisting of ball-type drain valve with hose end cap and pipe nipple.

2. Basket Strainer:

a. Install basket strainer on housekeeping pad with rubber mat between pad and strainer (See Section 23 05 48: Vibration Isolation for specs on rubber mat).

b. Provide manual air vent in top of cover.

c. Provide ball valve nipple and plug for drain valve assembly. Valve to be 3/4" unless otherwise noted.

B. Thermometers and Accessories:

1. Install and adjust thermometers for optimum visibility.
2. Provide thermometers where indicated on schematic flow diagram or schematic equipment details.
3. Install thermometers in compatible thermometer wells.

C. Pressure Gauges and Accessories:

1. Install and adjust gauge for optimum visibility.
2. Provide ball valve shut-off for all hydronic gauges.
3. Provide a manifold valve to facilitate the use of a single gauge to monitor pressure differential from various points of a single piece of equipment (i.e. pump; strainer suction; pump suction; pump discharge, etc.). Mount valve for optimum visibility and access.
4. In lieu of the trumpet valve the contractor may assemble individual components using ball valves as the isolation valve provided the same functions of the trumpet valve are duplicated.
5. Provide piston type snubbers for pump service.
6. Provide filter type snubbers for all other fluid services.
7. Open shut-off valve only enough to obtain accurate reading. Valve to gauge to be closed at all other times.

D. Pressure and Temperature Test Ports:

1. Install in upright or vertical position as indicated on schematic flow diagram or schematic equipment details.
2. Install in tee or welded outlet.
3. They shall be located upstream and downstream of every strainer.

E. Pressure and Temperature Test Kit: Turn complete kits in good working condition over to Owner, when the Owner takes over the building.

F. Pump Suction Diffuser:

1. Provide suction diffuser for each end suction pump unless design provides for 5 diameters of straight pipe upstream of suction inlet.
2. Support weight of suction diffuser independent of pump.
3. Provide blow-down tap sized nipples, 90^{o}F, ball valve and plug for blow-down valve assembly.
4. After system has been thoroughly cleaned and flushed and prior to turning over to Owner, remove the fine mesh strainer. Turn the strainer over to Owner.

G. Install miscellaneous control devices such as thermometer wells, tees for flow measuring stations, connections for differential pressure sensors, etc.

END OF SECTION 23 05 19

SECTION 23 05 23 – GENERAL-DUTY VALVES FOR HVAC 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 WORK INCLUDED

A. Automatic Flow Control Valves.

B. Ball valves.

C. Butterfly valves.

D. Check valves.

E. Combination Automatic Flow Control and Shutoff Valves.

F. Combination Strainer and Shutoff Valves.

G. Coil Hook-Up Connections

H. Drain valve.

I. Relief Valve.

J. Valves for Mechanical Joint Systems.

K. Wheel operators.

1.3 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this Section to the extent referenced. The publications are referenced to in the text by the basic designation only.

1. American National Standards Institute (ANSI).
2. American Society for Testing and Materials (ASTM).

1.4 SUBMITTALS

A. Submit schedule and cut-sheets indicating service, make and model number, pressure class, end type and usage (i.e., balance, shut-off).

B. Product data shall be included in the operation for maintenance instruction manuals along with installation, operation and maintenance instructions.

C. Refer to Division 01 for Submittal requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Automatic Flow Control Valves:

1. Flow Design, Inc.
2. Griswold
3. Nexus Controls
4. Tour & Andersson
5. Victaulic Company

B. Ball Valves:

1. Apollo
2. Crane Company
3. Milwaukee Valve.
4. Nibco, Inc.
5. Stockham
6. Victaulic Company
7. Watts

C. Butterfly Valves:

1. API International, Inc.
2. Bray International, Inc.
3. Crane Company
4. Milwaukee Valve
5. Nibco, Inc.
6. Stockham
7. Victaulic Company

D. Check Valves:

1. API International, Inc.
2. Hammond Valve
3. Milwaukee Valve
4. Mueller Steam Specialty, Co. (Muessco)
5. Nibco, Inc.
6. Stockham
7. Victaulic Company

E. Combination Automatic Flow Control and Shutoff Valves:

1. Flow Design, Inc.
2. Griswold
3. Nexus Controls
4. Tour & Andersson
5. Victaulic Company

F. Combination Strainer and Shutoff Valves:

1. Flow Design, Inc.
2. Griswold
3. Nexus Controls
4. Tour & Andersson
5. Victaulic Company

G. Coil Hook-Up Connections:

1. Victaulic Company

2. Owner Approved Equal.

H. Drain Valves:

1. Apollo.
2. Nibco, Inc.
3. Watts

I. Relief Valve:

1. Watson McDaniel Co.
2. Owner Approved Substitution.

J. Valves for Mechanical Joint Systems: Where a mechanical joint system is proposed, valves shall be furnished by the system supplier where appropriate and shall be equal to those specified.

K. Wheel Operator:

1. Babbitt
2. Roto Hammer
3. Approved Equal.

2.2 FABRICATION

A. Automatic Flow Control Valves:

1. HVAC Water Service:

a. Size ½" thru 2-1/2": Brass wye body design, thread or sweat connection, ground joint union, dual temperature and pressure test ports extended to clear required insulation, range 20°F to 230°F rated at 400 psi water. Stainless steel or nickel plated piston brass orifice and spring, replaceable without removing from installation, factory set to control the flow rate within 5% of the tagged rating over an operating pressure differential of at least 10 times the minimum required for full flow condition. GPM and direction of flow shall be clearly marked on flow control valves. Wide open pressure drop shall not exceed 10 ft. Valves shall be calibrated for the fluid being pumped. Based on Victaulic 76-Series or Flow Design, Inc. AutoFlow Model YR

b. Size 2-1/2" thru 12": Ductile iron body, wafer style connection, dual temperature and pressure test ports, range 20°F to 230°F rated at 150 psi. Stainless steel or nickel plated piston brass orifice and spring, factory set to control the flow rate within 5% of the tagged rating over an operating pressure differential of at least 10 times the minimum required for full flow condition. GPM and direction of flow shall be clearly marked on flow control valves. Wide open pressure drop shall not exceed 10 ft. Valves shall be calibrated for the fluid being pumped. Based on Victaulic 76-Series or Flow Design, Inc. AutoFlow Model WS.

B. Ball Valves:

1. HVAC water service:

a. Size 1/4" thru 2". Two piece, adapter loaded, full port type with brass body, threaded or sweat connection, stainless steel stem, stainless steel

ball, teflon or silicone bronze seat, steel lever handle, indicator stop, 150 lb. 600 WOG.

b. Size ½” thru 2”.

1) Two piece, standard port type with brass body, Vic Press 304™ connection, brass ball and stem, Teflon seat, carbon steel handle, 300 CWP. Victaulic Series P589.

2) Three piece, full port type with stainless steel body, Vic Press 304™ connection, stainless steel ball and stem, PTFE seats, stainless steel handle, 400 CWP. Victaulic Series P569.

c. Valves installed in insulated piping to have extended handles to clear insulation. Stem extension shall be made of a non-thermal conducting material with a sleeve to form an insulated vapor seal after the valve is insulated. Based on Nibco T-585-70-66.

C. Butterfly Valves:

1. HVAC water service – Above Ground Use:

a. Size 2-1/2" thru 4": 416 stainless steel stem, lug wafer body drilled and tapped for isolation and removal of downstream piping, cast iron or ductile iron body, long neck body extended to allow for a minimum of 2" insulation, aluminum bronze or stainless steel disc, bubble tight EPDM seat, infinite position, memory stop handle. Class 150, 20°F to 210°F range. Based on Nibco LD-2000-3.

b. Size 2-1/2" - 24" grooved end: Ductile iron body to ASTM A-536 with electroless nickel plated or PPS coated ductile iron disc to ASTM A-536, offset stainless steel stem, full 360° seating. EPDM pressure responsive seat in sizes through 12”. 2-1/2" - 4" to have infinitely variable memory stop handle. Valves 6" and above to have gear operator. Valve has bubble tight shut off up to 300 psi and 230^{o}. Valve will have extended neck allowing up to 2" insulation. Basis of Design: Victaulic Vic300 MasterSeal and AGS-Vic300.

c. Valves installed in insulated piping to have extended handles to clear insulation.

D. Check Valves:

1. HVAC water service.

a. Horizontal spring check valve:

(1) Size 1/4" thru 2". Bronze body threaded or sweat connection, inline, bronze seat, renewable teflon or bronze, 125 lb. SWP-200 lb. WOG (non-shock). Based on Nibco S-480.

b. Spring check valve:

(1) Size 1/2" thru 2". Bronze body thread or sweat connection, "Y" pattern, lead free, inline lift type, spring actuated, resilient discs. Temperature rating 300^{o}. Based on Nibco T-480-Y-LF or S-480-Y-LF or approved substitution.

E. Combination Automatic Flow Control and Shutoff Valves:

1. HVAC Water Service:

   a. Size ½" thru 2: Brass wye body thread or sweat connection, union, two-temperature and pressure test port extended to clear require insulation, brass or bronze ball valve with stainless steel ball and stem, non-thermal conductive material type actuator extended to clear required insulation for chilled water applications, steel lever type for heating applications. Range 20°F to 230°F rating 400 psi water. Stainless steel or nickel plated piston brass orifice and spring, replaceable without removing from installation, factory set to control the flow rate within 5% of the tagged rating over an operating pressure differential of at least 10 times the minimum required for full flow condition. GPM and direction of flow shall be clearly marked on flow control valves. Wide open pressure drop shall not exceed 10 ft. Valves shall be calibrated for the fluid being pumped. Based on Victaulic 76-Series or Flow Design, Inc. AutoFlow Model AC.

F. Combination Strainer and Shutoff Valves:

1. HVAC Water Service:

   a. Size ½" thru 2": Brass body, thread or sweat connection, ground joint union, temperature and pressure test port extended to clear required insulation (on each side of the valve), ball valve with non-thermal conductive material type actuator extended to clear required insulation for chilled water applications, lever type for heating applications. Removable stainless strainer, 40 mesh for .25 gpm and up, 20 mesh for 1.25 gpm and up. Unit side drain and strainer blow-down valve. Rated at 400 PSIG. Based on Victaulic Series 78Y or Flow Design, Inc AutoFlow Model YC.

G. Coil-Hook-up Connections: Victaulic Koil-Kits Series 799 or 79V may be used at coil connections. The kit shall include a Series 786/787/78K circuit balancing valve, Series 78Y Strainer-Ball, Series 78U Union-Port fitting, with Series 78T ball valve and required coil hoses. A Style 793 and/or 794 differential pressure controller shall be provided as required. A meter shall be provided by the valve manufacturer that shall remain with the building owner after commissioning.

H. Drain valves:

1. HVAC water service:

   a. Size 1/2" and 3/4". Two piece, adapter loaded, single reduced port type with brass body, iron pipe thread inlet or sweat inlet, 3/4" hose thread outlet, brass cap and chain at outlet, stainless steel stem, stainless steel ball, teflon or silicone bronze seat, steel lever handle, indicator stop, 150 lb. 600 WOG.
   b. Valves installed in insulated piping to have extended handles to clear insulation.
   c. Based on Watts B-6000-CC or B-6001-CC or Nibco T-585-70HC.

I. Relief Valve:

1. ½" bronze body and spring case with stainless steel ball and cadmium plated steel spring.
2. Suitable for duty to 300 PSIG at 300°F (non-shock rating).

3. Pressure range 25 to 100 PSIG (adjustable).
4. Designed to relieve excessive system pressure from isolated secondary chilled water system to primary ice water system which may be under pressure. Valve to open upon increase in pressure above setpoint and instantly close upon relief of excess pressure.
5. Valve loading adjustable by spring within pressure range listed above. Based on Watson McDaniel Type R relief valve.

J. Valves for Mechanical Joint Systems: Valves shall be constructed as described above for the type used.

K. Wheel Operators: Ductile iron sprocket rim equal to or larger than hand wheel, malleable iron guide arm, spider rust proof chain. Grooved end valves have chain wheels mounted to the gear operator hand wheels, sprocket rim and guide arms are made of cast aluminum, chain is galvanized steel. Based on Roto Hammer or Babbitt.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide shut-off valves on the inlet and outlet of each piece of equipment at the take-off of each major branch from a header and at the base of each pipe riser in order to facilitate service.

B. Provide drain valves at the base of each pipe riser and at each piece of equipment to facilitate service.

C. Provide locking device on handle of the expansion tank isolation valve to prevent accidental closing.

D. There shall not be any piping, valves, and strainers of any kind and their accessories in front of access panels for the air handling units. There shall be ample room for the full swing of the air handling hinged doors.

E. Chilled water piping systems shall be designed with accessible isolation valves entering each building.

3.2 INSTALLATION

A. Automatic Flow Control Valves:

1. Install with taps in upright or vertical position.
2. Tag valve for:

    a. Type of service.
    b. Flow in GPM.

3. The contractor shall assume the responsibility to obtain the necessary gauges and thermometers to properly take the differential pressure and temperature readings from the flow control valves.
4. All flows shall be verified.

B. Ball Valves:

1. Install valves with adequate access to lever actuator.
2. Provide adequate space for actuator handle in the open and closed position and

for packing replacement.

3. Provide infinite position handle with memory stop on the outlet of all heat exchangers for balancing purposes.

C. Butterfly Valves:

1. Install valve between face of 125# or 150 standard ANSI flanges or standard grooved couplings.
2. Assure unrestricted valve movement after installation. Valves should be installed with stem of valve parallel to floor.

D. Check Valves:

1. Horizontal swing check valves: Install valve with swing disc in the pendent position, cover in upright position.
2. Vertical lift check valve:

    a. Install valve in vertical position, upward flow.
    b. Flanged valves will be installed between 125# or 150 ANSI flanges or other flanged valves.
    c. A spool piece a minimum of 6" face to face will be used to separate a vertical lift check valve and a butterfly valve.
    d. Inspect the face of the flange and valve for casting/matching burrs. If burrs exist remove by draw filling prior to gasket placement.
    e. Grooved end check valves shall be installed with standard grooved couplings.

E. Combination Flow Control and Shutoff Valves:

1. Install with taps in upright position in a manner that will allow the tap to be used as an air vent.
2. Tag valve for:

    a. Type of service.
    b. Flow in GPM.

3. Obtain the necessary gauges and thermometers to properly take the differential pressure and temperature readings from the flow control valve.
4. All flows shall be verified.

F. Combination Strainer and Shutoff Valves:

1. Install with taps in upright position in a manner that will allow the tap to be used as an air vent.
2. All strainers shall be blown down prior to turning system over to Owner.

G. Coil Hook-Up Connections: Installation based on manufacturer’s instructions.

H. Drain Valves: Install valves to provide adequate space for hand wheel, access, stem travel, disc replacement cap removal and clearance for easy hose connection without crimping hose.

I. Relief Valve:

1. Install 3/4" valve in upright, vertical position with inlet pressure connection to bottom.

2. Adjust relief pressure to approximately 90 PSIG differential pressure per manufacturer's written instructions.
3. Pipe downstream connection to floor drain.

J. Valves for Mechanical Joint Systems: Valves shall be installed as described above for the type used.

K. Wheel Operator:

1. Install operators on valves in excess of 7'-0" above finished floor.
2. Extend chains to 5'-0" above finished floor and hook to clips arranged to clear walking aisles.

END OF SECTION 23 05 23

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to Division 07 for firestopping requirements.

1.2 WORK INCLUDED

A. Inserts, Shells and Upper Attachments.

B. Pipe Hangers, Rods, Supports and Accessories.

C. Pipe Sleeves.

D. Pipe Seals.

E. Duct Hangers and Supports.

F. Duct Sleeves.

G. Fabricated Steel Support.

1.3 QUALITY ASSURANCE

A. Design of pipe supporting elements shall be in accordance with ANSI B31.1.

B. Fabrication and installation of pipe hangers and supports shall be in accordance with the following Manufacturers Standardization Society (MSS) Standards.

1. SP-58 Pipe Hangers and Supports: Materials, Design and Manufacture.
2. SP-69 Pipe Hangers and Supports: Selection and Application.
3. SP-89 Pipe Hangers and Supports: Fabrication and Installation Practices.

C. Steel angles, channels and plate shall be in accordance with ASTM A36, red primed or hot dipped galvanized for interior applications, and hot galvanized for exterior applications.

D. Bolts, including nuts and washers, used for fabricating steel members shall be in accordance with ASTM A325 and shall be stainless steel or plated for corrosion protection. Plain steel components are unacceptable.

E. Welding of steel members shall be in accordance with AWS D1.1.

F. Duct hangers and supports shall be in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible as applicable.

G. Steel supports for ducts, pipe anchors, pipe guides, and piping supported from below shall be fabricated in accordance with AISC Specification for the Design, Fabrication and Erection of Structural Steel for buildings. If required, the contractor shall include the cost of the services of a structural engineer to design or review the system.

1.4 APPLICABLE PUBLICATIONS

A. Applicable sections of the publications listed below form a part of this Section. The publications are referenced to in the text by the basic designation only.

1. American Institute of Steel Construction (AISC)
2. American National Standards Institute (ANSI)
3. American Society for Testing and Materials (ASTM)
4. American Welding Society (AWS)
5. The Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS)
6. Sheet Metal and Air Conditioning Contractor's National Association, Inc. (SMACNA)

1.5 SUBMITTALS

A. Submit schedule indicating type of hanger to be used by system and pipe size. Include rod size for each hanger size.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Inserts, Shells and Upper Attachments:

1. Anvil International, Inc.
2. Carpenter Paterson, Inc.
3. Cooper B-Line®, Inc.
4. Elcen Metal Products
5. Hilti
6. Michigan Hanger Company
7. PHD Manufacturing, Inc.
8. Unistrut®

B. Pipe Hangers, Rods, Supports and Accessories:

1. Anvil International, Inc.
2. Carpenter Paterson, Inc.
3. Cooper B-Line®, Inc.
4. Elcen Metal Products
5. Hilti
6. Michigan Hanger Company
7. PHD Manufacturing, Inc.
8. Unistrut®

C. Pipe Sleeves:

1. Metraflex – Metraseal
2. Thunderline Corporation - Link Seal
3. Owner Approved Substitution.

D. Pipe Seals:

1. Metraflex – Metraseal
2. Thunderline Corporation - Link Seal
3. Owner Approved Substitution.

E. Duct Hangers and Supports: Fabricated per Specifications

F. Duct Sleeves: Fabricated per Specifications

G. Fabricated Steel Support: As Detailed on Drawings.

2.2 FABRICATION

A. Inserts, Shells and Upper Attachments:

1. Inserts; MSS Type 18; malleable iron body and nut, galvanized finish, opening in top of insert for reinforcing rod, lateral adjustable. Rated for 1,140 lbs. Based on Anvil Fig. 282.
2. Shells: Steel shell and expander plug, snap off end fastener. Based on Phillips Concrete Fasteners Red Head.
3. Upper Attachments:

a. Top beam clamps; MSS Type 19: Malleable iron galvanized finish clamp, hardened steel cup point set screw and locknut. Rating is contingent on rod and bolt size. Based on Anvil Fig. 94.
b. Bottom Beam Clamp; MSS Type 23: Malleable iron galvanized finish clamp, hardened steel cup point set screw and locknut, and retaining clip. Rating is contingent on rod and bolt size. Based on Anvil Fig. 86 Clamp and Fig. 89 Retaining Clip (or Fig. 87).
c. Welded Beam Attachment; MSS Type 22: Carbon steel suitable for eye rod or rod and locknut, rating is contingent on rod and bolt size. Based on Anvil Fig. 66.
d. Center Beam Clamp; MSS Type 21: Malleable iron jaw and square head bolt and nut with galvanized finish. Rating is contingent on rod and bolt size. Based on Anvil Fig. 134.
e. Center Beam clamp; MSS Type 29: Forged steel, weldless eye nut, tie rod to secure clamp to beam all with galvanized finish, rating is contingent on rod and bolt size. Based on Anvil Fig. 292 or 292L.

B. Pipe Hangers, Rods, Supports and Accessories:

1. Pipe Hangers:

a. Clevis Hanger; MSS Type 1: Carbon steel, galvanized for interior and exterior use, sized to accommodate required insulation. Rating is contingent on rod and bolt size. Based on Anvil Fig. 260 or 300.
b. Pipe Rings; MSS Type 10: Carbon steel, galvanized for black steel and insulated pipe copper or copper plated or rubber coated for copper pipe. Threaded swivel, sized to accommodate required insulation. Rating is contingent on rod and bolt size. Based on Anvil Fig. 69 or Fig. 97C for copper pipe.
c. Adjustable Roller Hanger; MSS Type 43: Cast iron roll, carbon steel yoke rod roll and hex nut with galvanized finish. Sized to accommodate insulation. Rating is contingent on rod and bolt size. Based on Anvil Fig. 181.

2. Rods:

a. Size 3/8" and up: All thread steel rod electro galvanized. Sizing for pipe or equipment support as follows:

Copper Tube/Plastic Pipe Size	Steel/Cast Iron Pipe Size	Rod Size	Max Equip. Load
¼” to 2”	¼” to 2”	3/8”	730 lbs.
2-1/2” to 5”	2-1/2” to 3”	½”	1350 lbs.
6”	4” to 5”	5/8”	2160 lbs
8” to 12”	6”	¾”	3230 lbs.

b. Rods may be reduced one size for double rod hangers with 3/8” minimum diameter, or when other paragraphs require a minimum of 2 hangers per section provided the minimum diameter of 3/8” in maintained. Based on Anvil Fig. 146.

3. Supports:

a. Pipe Saddle; MSS Type 38: Cast iron saddle, black steel lock nut nipple, cast iron reducer all with galvanized finish. Suitable for standard field cut and threaded galvanized steel pipe. Cast iron floor flange. Based on Anvil Fig. 264 Saddle, Fig. 63 Floor Flange.
b. Pipe Saddle Cold Piping: MSS Type 40. Single bonded unit consisting of a galvanized metal shield and a molded section of rigid polyurethane foam insulation. Rigid urethane foam shall have a density of 4 pounds per cubic foot, a thermal conductivity of 0.13 Btu.in/sq.ft./hr.^{o}F at 75^{o}F mean temperature. Insulation thickness to be equal to thickness specified for pipe being supported.
c. Adjustable Pipe Roll and Base; MSS Type 46: Cast iron base plate steel stand and roll, adjusting screws with galvanized finish. Based on Anvil Fig. 274.
d. Welded Steel Bracket; MSS Type 32: Welded carbon steel rate for 1500 lbs., with galvanized finish. Rating is contingent on rod and bolt size. Based on Anvil Fig. 195.
e. Riser Clamps; MSS Type 8: Carbon steel, galvanized finish for black steel or galvanized pipe, plastic coated for cold steel, copper, glass or brass pipe rated for a minimum of 220 lbs. at 3/4" size. Based on Anvil Fig. 261.

4. Accessories:

a. Protective Shields; MSS Type 40: Carbon steel, galvanized minimum of 12" length sized for required insulation. Based on Anvil Fig. 167.
b. Protective Saddles; MSS Type 39: Carbon steel plate, minimum of 12" length, sized for required insulation. Based on Anvil Fig. 160 thru 165.
c. Steel Turnbuckle; MSS Type 13: Forged steel, galvanized finish with locknuts. Rated at a minimum of 730 lbs. at 3/8" size. Based on Anvil Fig. 230.
d. Steel Clevis; MSS Type 14: Forged steel, galvanized finish with steel pin and cotter pin. Rated for a minimum of 730 lbs. at 3/8" size. Based on Anvil Fig. 299.
e. Weldless Eye Nut; MSS Type 17: Forged steel, galvanized finish. Rated for a minimum of 730 lbs. at 3/8" size. Based on Anvil Fig. 290 or 290L.

C. Pipe Sleeves:

1. Wall: Schedule 40 carbon steel pipe sized to accommodate pipe and insulation.

If sleeves are field cut coat cut edges with cold galvanizing spray, ZRC or equivalent.

2. Floor or Exterior Walls below Grade: Schedule 40 steel pipe with anchor and water stop hot dip galvanized after fabrication. Sleeve length will be sized to allow a minimum of 1/2" extension below floor or exterior side of a wall below grade and 1-1/2" extension above floor and 1/2" extension on interior side of an exterior wall below grade.
3. Roof: All penetrations of roof shall be in accordance with Division 07 requirements.
4. Based on Thunderline Corp. Link Seal Wall Sleeve.

D. Pipe Seals: Composition Plastic Pressure Plates, zinc coated bolts, nuts and metal parts, composition rubber sealing element designed for long term stability rated for temperatures of 40°F to +250°F. Based on Thunderline Corp. Link Seal LS Series.

E. Duct Hangers and Supports: Fabrication and application of duct hangers and supports shall be in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, Latest Edition, as applicable.

F. Duct Sleeves: Sleeves shall be provided for ducts penetrating concrete and masonry walls, stud framed fire rated walls, and poured- in-place concrete floors and roofs. Sleeves shall be sized to accommodate duct and insulation.

G. Fabricated Steel Supports: Field or shop fabricated supports to be galvanized interior and exterior.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Where applicable install in accordance with the manufacturers written installation instructions.

B. Where supports are in contact with copper pipe provide copper plated support, or wrap pipe with sheet lead.

C. Where supports are in contact with glass, aluminum or brass pipe provide plastic coating on supports, or wrap pipe with sheet plastic.

D. General interior supports, including attachments and pipe supports that are plain steel shall be cleaned of all rust, primed and painted black within one week of installation. At substantial completion all supports shall be free of rust and in a “like new condition”.

E. Hangers and supports, including attachments and pipe supports, exposed to weather or located in utility tunnels or accessible utility trenches or subject to spillage shall be hot dip galvanized after fabrication. At substantial completion all supports shall be free of rust and in a “like new condition”.

F. Fabricated steel supports exposed to weather (including pipe supports) or located in utility tunnels and accessible utility trenches or subject to spillage shall be hot dipped galvanized after fabrication, primed and painted black within one week of installation. Cut, welded, drilled, or otherwise damaged surfaces of galvanized coating shall be repaired. At substantial completion all supports shall be free of rust and in a “like new condition”.

3.2 INSTALLATION

A. Inserts, Shells and Upper Attachments:

1. Inserts:

   a. Contractor shall have inserts at site and dimensioned location drawings ready at the beginning of the involved concrete work.
   b. Install inserts by securing to concrete forms and inserting reinforcing rod thru the opening provided in the insert in accordance with shop drawings.
   c. Provide necessary supervision while concrete is being poured to correct any misalignment caused by the concrete.

2. Shells: Size shell length to assure a minimum of 1" solid concrete remaining from shell end to concrete face.
3. Upper Attachment:

   a. Select proper attachment for building construction.
   b. For plain steel devices, prime with black paint prior to installation.
   c. Adjust attachment location for proper alignment and no more than 4 deg. offset from a perpendicular alignment.
   d. If proper alignment cannot be achieved from the existing building structure provide a trapeze type support size to handle the design load with a minimum safety factor of 5.

B. Pipe Hanger, Rods, Supports and Accessories:

1. Select proper hanger for piping systems.
2. The location of hangers and supports shall be coordinated with the structural work to ensure that the structural members will support the intended load.
3. Provide hex head nut on rod at top and bottom of clevis hanger yoke, and at each rod connection to intermediate and upper attachment. Rod nuts shall be securely locked in place.
4. Hanger rods shall be subject to tensile loading only. Where lateral or axial movement is anticipated, use suitable linkage in hanger rod to permit swing.
5. Hangers shall be fabricated to permit adequate adjustment after erection while still supporting the load. Turnbuckles shall be provided where required for vertical adjustment of the piping.
6. For vibration isolation hanger intermediate attachment requirements for isolated equipment refer to Section 23 05 48 – Vibration and Seismic Controls for HVAC**.**
7. Supports for vertical piping shall be located at each floor or at intervals of not more than 15 feet and at intervals of not more than 8 feet from end of risers. Where supports are provided on intermediate floors spaced 15 feet or less between floors, no additional supports are required other than those specified for end of risers.
8. A hanger or support shall be provided adjacent to each piece of equipment to ensure that none of the pipe weight is supported from the equipment.
9. The maximum spacing between pipe supports for straight runs shall be in accordance with the following chart. If any deviation from the table exists within the manufacturers written installation instructions, whichever spacing reflecting the smaller centerline to centerline dimension shall be used.

MAXIMUM HORIZONTAL PIPE HANGER AND SUPPORT SPACING TABLE

a. Steel Pipe (Schedule 40 & 80):

1)	Up to 1":	7 ft. on center
2)	1-1/4" and larger:	10 ft. on center

b. Copper Pipe (Types L, K and M):

1)	Up to 1" size:	5 ft. on center
2)	1-1/4" and larger:	6 ft. on center

c. Ductile Iron and Cast Iron: Two hangers per section length.

d. Polyvinyl Chloride (PVC):

1)	Up to 1-1/2":	3 ft. on center
2)	2" and larger:	4 ft. on center

10. Hanger centerline spacing shall be reduced by 50% in areas of concentrated valves and/or fittings, also no more than a maximum distance of 12 inches from valves, fittings and/or couplings, or 24 inches from a change in direction.
11. Parallel piping may be supported by trapeze hangers consisting of steel angle, channel, or beam suspended by steel rods attached to upper structure. Piping may be supported above, or suspended below, the angle, channel, or beam.
12. Provide protective shields on all cold and dual temperature piping required to be insulated.
13. Provide protective saddles sized to match insulation thickness on all hot piping required to be insulated. Fill void between saddle and pipe with insulation as specified.
14. Provide turnbuckles on all hangers which require leveling or aligning.
15. Provide steel clevis where detailed and/or required.
16. Provide weldless eye nuts on hanger terminations where disassembly or swing may be required. Use in combination with steel clevis.

C. Pipe Sleeves:

1. Secure sleeves to forms for concrete construction. Ensure sleeves are not disengaged or misaligned by concrete placement operations.
2. Provide temporary cap for open end of sleeves to prevent entrance of concrete.
3. Provide temporary internal bracing where required preventing distortion of sheet metal sleeves by concrete placement operations.
4. Sleeves shall not be installed in structural members, except where indicated or approved.
5. Furnish sleeves to masonry contractor in advance of masonry work. Furnish dimensioned drawings indicating exact location of sleeves.
6. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface, except as indicated otherwise.
7. Sleeves passing through floors in wet areas, such as areas containing plumbing fixtures or floor drains, shall extend a minimum of 4 inches above the finished floor. Sleeves in wet areas shall be enclosed with 4 inch concrete curb.
8. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/4 inch clearance all around between the pipe and inside of sleeve, or between jacket over insulation and sleeve.
9. Provide membrane clamping devices on sleeves for waterproof floors.

10. Sleeves are not required in existing structures where openings through existing concrete floors, walls, or roof are core drilled.

D. Pipe Seals:

1. Provide pipe seals for all pipe sleeves used in:

a. External walls.
b. Floor slabs on grade.
c. Upper floors where spillage may occur.

E. Duct Hanger and Supports: Installation of duct hangers and supports shall be in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, Latest Edition, as applicable.

F. Duct Sleeves:

1. Secure sleeves to forms for concrete construction. Ensure sleeves are not disengaged or misaligned by concrete placement operations.
2. Provide temporary cap for open end of sleeves to prevent entrance of concrete.
3. Provide temporary internal bracing where required preventing distortion of sheet metal sleeves by concrete placement operations.
4. Sleeves shall not be installed in structural members, except where indicated or approved.
5. Furnish sleeves to masonry contractor in advance of masonry work. Furnish dimensioned drawings indicating exact location of sleeves.
6. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface, except as indicated otherwise.
7. Sleeves passing through floors in wet areas, such as areas containing plumbing fixtures or floor drains, shall extend a minimum of 4 inches above the finished floor. Sleeves in wet areas shall be enclosed with 4 inch concrete curb.
8. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/4 inch clearance all around between the duct and inside of sleeve, or between jacket over insulation and sleeve.
9. Provide membrane clamping devices on sleeves for waterproof floors.
10. Duct sleeves shall be secured to opening and have a flange turned back to wall to cover any irregularities in the opening provided for the sleeve.

G. Fabricated Steel Supports: Steel for supports shall be saw cut, with sharp edges ground smooth. After fabrication remove all foreign material, including welding slag and spatter, and leave ready for painting or galvanizing, as applicable.

END OF SECTION 23 05 29

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Vibration isolators.

B. Flexible pipe connectors.

1.3 QUALITY ASSURANCE

A. The vibration isolation materials manufacturer shall be responsible for the proper selection of spring rates to accomplish the specified minimum static deflections for all spring and pad type isolators based on the weight distribution of equipment to be isolated.

B. The vibration isolation materials manufacturer shall be responsible for the structural design of steel beam bases and concrete inertia bases to support mechanical equipment scheduled to receive a supplementary base.

C. Vibration isolation shop drawings shall show isolator locations, and load on each isolator, deflection, compressed spring height, solid spring height, spring diameters and color coding.

D. Where grooved-joint flexible pipe connectors are specified, manufacturer shall design the isolation system and include drawings showing all supports, restraints, etc. as required to ensure performance.

1.4 SUBMITTALS

A. Submit a schedule indicating make, model, type and deflection for each system or weight range.

B. Product data and shop drawings, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

C. Submit in accordance with Division 01 Requirements.

D. Submit manufacturer's certification of installation quality.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Vibration Isolators:

1. Amber/Booth Company
2. Mason Industries, Inc.
3. Peabody Noise Control, Inc. - Kinetics.
4. Vibration Mountings and Controls, Inc.

B. Grooved-Joint Flexible Pipe Connectors:

1. Tyler Pipe (Gustin-Bacon)
2. Unisource Manufacturing Inc.
3. Victaulic Company

C. Braided Flexible Pipe Connectors:

1. Flexonics
2. Keflex, Inc.
3. Mason Industries, Inc.
4. Metraflex Co.
5. Proco Products, Inc.
6. Southeastern Hose
7. Unisource Manufacturing Inc.
8. Wheatley Gaso, Inc.

2.2 MATERIALS

A. Vibration Isolators:

1. Type A: Vibration Hangers: Vibration hangers shall contain a steel spring and 0.3" deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing thru a 30^{o} arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Based on Mason Model 30N.
2. Type B: Neoprene Isolation Pads: Neoprene isolation pads shall be single rib or crossed, double rib neoprene in-shear pads, in combination with steel shims when required, having minimum static deflections as tabulated. All neoprene pads shall be true neoprene in-shear using alternately higher and lower ribs to provide effective vibration isolation, and shall be molded using 2500 PSI tensile strength, oil resistant, compounds with no color additives. Pads shall be 45 or 65 durometer and designed to permit 60 or 120 psi loading, respectively, at maximum rated deflections. Neoprene in-shear isolation pads shall be provided to meet tabulated minimum operating static deflections without exceeding published maximum static deflections. Use single or, crossed, double rib or laminated composites of both as required. When two or more pads of ribbed material are laminated, they shall be separated by, and bonded to, a galvanized steel shim plate between each layer. The minimum height shall be 2” of all pad or pad combinations. Any neoprene pads exposed to sunlight shall have a UV protection applied to them. Based on Kinetics NPS, NPD, NGS or NGD.

B. Flexible Pipe Connectors:

1. Grooved-joint flexible pipe connectors shall consist of a minimum of three flexible pipe couplings. Coupling shall contain a resilient elastomeric gasket conforming to the internal cavity of the coupling housing and providing a pressure responsive seal against the pipe to create a permanent leak-tight seal. Assembly shall permit expansion, contraction and deflection and shall dampen noise and vibration.
2. Braided flexible pipe connectors constructed of stainless steel annular corrugated metal surrounded with a woven braid of high tensile stainless steel. Units capable of absorbing pump vibration and noise accept thermal expansion and reduce piping stress due to minor misalignment and pressure variations. Sizes 1/2"

through 2" to have carbon steel male pipe thread connections. Sizes 2-1/2" and larger to have carbon steel plate flanges with ASA #150 bolt hole patterns. Sizes through 8" to be suitable for 150 psig working pressure at 200°F.
Based on Keflex KSSPC.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. All floor mounted equipment shall be installed on a housekeeping pad, in addition to any isolation or inertia base requirement as specified in Section 23 05 10 - Basic Materials and Methods for HVAC Systems.

B. Installation of all vibration isolation materials and supplemental equipment bases specified in this section of the specifications shall be accomplished following the manufacturers written instructions.

C. On completion of installation of all isolation materials and before start up of isolated equipment all debris shall be cleared from areas surrounding and from beneath all isolated equipment, leaving equipment free to move on the isolation supports.

D. No rigid connections between equipment and building structure shall be made that degrades the noise and vibration isolation system herein specified. Electrical conduit connections to isolated equipment shall be looped to allow free motion of isolated equipment.

E. Adjust all isolators for uniform support.

F. Readjust all isolators after system start-up to assure constant support.

3.2 INSPECTION

A. The Contractor shall notify the local representative of the vibration isolation materials manufacturer prior to installing any vibration isolation devices. The Contractor shall seek the representative’s guidance in any installation procedures he is unfamiliar with.

B. The local representative of the vibration isolation materials manufacturer shall conduct periodic inspections of the installation of materials herein specified, and shall report in writing to the Contractor any deviations from good installation practice observed.

C. On completion of installation of all noise and vibration isolation devices herein specified, the local representative of the isolation materials manufacturer shall inspect the complete system and report in writing any installation errors, improperly selected isolation devices, or other fault in the system that could affect the performance of the system.

D. The installing Contractor shall submit a report to the Owner's Representative and Engineer of Record including the manufacturer's representative’s final report indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

3.3 VIBRATION ISOLATION SCHEDULE:

A. Chillers (Grade Level):

1. Base Type: Housekeeping Pad.
2. Isolator type: "B"

3. Deflection: .06"
4. Height: 2” from grade
5. Accessories: Flexible pipe connector (Section 23 33 00 – Air Duct Accessories).

B. Pumps (Grade Level):

1. Base Type: Housekeeping Pad.
2. Isolator type: None Required.
3. Deflection: N/A
4. Accessories: Flexible Pipe Connectors (Section 23 33 00 – Air Duct Accessories).

C. Terminal Boxes:

1. Base type: None required.
2. Isolator Type: None required.

D. Ductwork:

1. Base type: None required.
2. Isolator Type: None required.

E. Packaged Air Handling Units:

1. Base type: None required.
2. Isolator Type: Internal spring type provided with AHU.
3. Deflection: 2"
4. Accessories: Flexible duct connectors (Section 23 33 00 – Air Duct Accessories and Internal Fan Isolation).

F. Condensing Units:

1. Base type: Rubber pads
2. Isolator Type: None required.
3. Deflection: .25”

END OF SECTION 23 05 48

SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Piping and equipment identification.

1.3 SUBMITTALS

A. Refer for Division 01 for submittal requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Piping and Equipment Identification:

1. Communications Technology Corp.
2. Craftmark Identification Systems, Inc.
3. EMED Co., Inc.
4. Florida Marking Products, Inc.
5. Marking Services, Inc.
6. Seton Name Plate Corp.
7. W.H. Brady Co., Signmark Division

2.2 FABRICATION

A. Piping and Equipment Identification:

1. Pipe markers: Sub-surface printed plastic, with protective undercoating. Markers shall be permanently curled for snap-on installation for pipe sizes (including insulation) up to 6” diameter. For external diameters above 8”. Marker shall be secured using cable ties for indoor use and stainless steel banding or ultraviolet resistant plastic for exterior use. Markers for outdoor installation shall be over-laminated with Tedlar™ on polyester to prevent ultraviolet to avoid damage and fading. Markers shall identify the pipe contents and direction of flow through 360 degree visibility range. Marker size, letter size, letter color, wording and background color shall be in accord with ANSI A13.1 – Scheme for the Identification of Piping Systems. Based on Marking Services Inc. Model MS-970 Coiled Plastic Markers for indoor use and Model MS-995 Maxilar Marker for exterior use.
2. The marker shall be 1/16 inch thick plastic with a satin surface and white core. Color of the marker shall match color of piping identification system. Lettering shall be engraved through the surface color to expose the core color. Plate size shall be ¾ inch by 2-1/2 inch, with 3/16 inch high lettering for ceiling grid labeling. Plate manufacturer shall furnish suitable adhesive for permanently attaching plate to ceiling grid.
3. Valve tags: Contractors Option:

a. Indoor:

1) 19 gauge brass, 1-1/2 inch round, with 1/4 inch high black pipe service letter abbreviation above 1/2 inch high black valve number. Pipe service letter abbreviation shall be in accord with legend on drawings. Valve tag attachment shall be 4 ply 0.018 copper wire meter seal or #6 solid brass bead chain with locking link. Based on Marking Services Inc.
2) 1/16 inch thick plastic, 1-1/2” round, with ¼ inch high black pipe service abbreviation above 1/2 inch high black valve number. Pipe service letter abbreviation shall be in accord with legend on drawings. Color of valve tag shall match pipe marker color. Valve tag attachment shall be 4 ply 0.018 copper wire meter seal or #6 solid brass bead chain with locking link. Based on Marking Services Inc.

b. Outdoor Service:

1) 19 gauge brass, 1-1/2 inch round, with 1/4 inch high black pipe service letter abbreviation above 1/2 inch high black valve number. Pipe service letter abbreviation shall be in accord with legend on drawings. Valve tag attachment shall be 4 ply 0.018 copper wire meter seal or #6 solid brass bead chain with locking link. Based on Marking Services Inc.
2) 19 gauge Type 304 stainless steel, 1-1/2” round, with ¼ inch high pipe service abbreviation above 1/2 inch high black valve number. Pipe service letter abbreviation shall be in accord with legend on drawings. Color of valve tag shall match pipe marker color. Valve tag attachment shall be 4 ply 0.018 stainless wire meter seal or #6 Type 304 stainless steel bead chain with locking link. Based on Marking Services, Inc.

4. Valve chart frame: Self-closing, satin-finished, extruded aluminum with glass window, 8-1/2 inch by 11 inch chart size.
5. Equipment nameplates:

a. Indoor: Shall be 1/16 inch thick plastic with black satin surface and white core. Lettering shall be engraved through the surface color to expose the core color. Plate size shall be a minimum of 2-1/2 inch by 4 inch, with 3/4 inch high lettering for equipment and 3/4 inch by 2-1/2 inch, with 3/16 inch high lettering for ceiling grid labeling. Equipment identifying name and number shall be in accord with schedules on the Contract Documents. Plate manufacturer shall furnish pre-drilled hole locations for pop riveting. Where pop riveting is not suitable, a suitable adhesive for permanently attaching plate to equipment shall be provided.
b. Outdoor: Shall be 125 Mil rigid plastic constructed of printed legend sealed between two layers of chemically-resistant plastic to resist ultraviolet damage. Plate size shall be a minimum of 2-1/2 inch by 4 inch, with 3/4 inch high lettering for equipment. Equipment identifying name and number shall be in accord with schedules on the Contract Documents. Plate manufacturer shall furnish pre-drilled hole locations for pop riveting. Where pop riveting is not suitable, a suitable adhesive for permanently attaching plate to equipment shall be provided.
c. Based on Marking Services Inc. Model MS-215 Max-Tex.

PART 3 - EXECUTION

3.1 GENERAL

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

3.2 INSTALLATION

A. Piping and Equipment Identification:

1. Install pipe markers adjacent to each valve and fitting, at each branch connection, on each side of wall, floor, and ceiling penetrations, where entering and leaving underground areas, and at minimum 40 foot spacing on horizontal and vertical pipe runs. Markers shall be arranged for easy reading at eye level.
2. Provide valve tags on all valves exposed or concealed unless otherwise noted.
3. Attach valve tag to stem of each valve to be tagged. Valve numbers shall follow in sequence the Owner's existing valve numbers, where applicable.
4. Provide a marker for each valve and equipment to be tagged, and permanently adhered to the ceiling metal grid below the valve. The information on this tag shall match the tag on the valve and include valve service and number.
5. Provide a minimum of 4 valve charts. Chart information shall indicate job name, Contractor name, date of installation, valve number, valve location, valve type, valve purpose, and system in which installed. Mount framed chart in equipment room, and insert copy of chart in each operating and maintenance manual under separate tabbed section labeled "Valve Chart". Where project drawings include a piping flow schematic, request AutoCad file from Engineer and label all of the valves according to the valve chart and frame in an 18” x 24” frame in main mechanical or pump room.
6. Provide air and water flow diagrams installed in waterproof, laminated frames on the wall in each Mechanical Room. Air flow diagrams shall show locations of dampers, sensors, and exhaust fans associated with the air handling unit. Water flow diagrams shall show shut-off valves and control valve locations.
7. Permanently affix nameplate to each item of equipment using stainless steel pop rivets. Where irregular surface impede direct attachment of plates, affix plate to sheet metal bracket and attach bracket to equipment with screws, bolts or suitable adhesive from nameplate manufacturer.
8. Refrigeration System - Additional Requirements:

a. Marking and Signage:

1) Provide a permanent sign containing the following information:

(a) Name and address of installer.
(b) Kind of refrigerant.
(c) Lbs. of refrigerant.
(d) Field test pressure applied.

2) Provide a permanent sign: Main electrical supply, i.e., main compr. disc.
3) Provide metal tags with 0.5" letters:

(a) Shut-off valves to each vessel, i.e., L.P. receiver shut-off.
(b) Relief valve.

4) Piping shall be marked as either:

(a) Refrigerant - High Pressure - Liquid or Hot Gas.
(b) Refrigerant - Low Pressure - Suction, Pumped Liquid Supply or Pumped Liquid Return.

END OF SECTION 23 05 53

SECTION 23 05 80 - AIR CONTROL AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Pressurized Expansion Tank

B. Air Separator

C. Automatic Air Vent

1.3 QUALITY ASSURANCE

A. Expansion tanks shall be constructed with materials and standards which comply with the following standards:

B. American Society of Mechanical Engineers (ASME) Codes:

C. Boiler and Pressure Vessel Code: Section VIII Pressure Vessels, Division 01.

1.4 SUBMITTALS

A. Submit shop drawings in accordance with Division 01 Requirements.

B. Submit schedule indicating make, model, size, etc. by system.

C. Submit statement of Code compliance where applicable.

D. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURE

A. Pressurized Expansion Tank:

1. American Wheatley
2. Amtrol, Inc.
3. Armstrong Pump Company
4. Bell & Gossett
5. Taco, Inc.
6. Wood Industries, Inc.

B. Air Separator:

1. American Wheatley
2. Armstrong Pump Company.
3. Bell & Gossett, Inc.
4. Spirovent
5. Taco, Inc.

6. Wood Industries, Inc.

C. Automatic Air Vent:

1. Armstrong Pump Company
2. Bell & Gossett. Inc.
3. Taco, Inc.

2.2 FABRICATION

A. Pressurized Expansion Tank:

1. Closed type, welded steel construction, ASME stamped and rated for 125 PSIG working pressure at 240°F, National Board Form U-1A attached.
2. Replaceable elastomeric bladder to separate water and air.
3. Tappings for system connection, remote air connection, charging valve enclosure, drain connection.
4. Bolted and gasketed handhole for bladder replacement, lifting ring top and side, integral steel base ring for vertical mounting.
5. Factory precharged with air to scheduled pressure.
6. Factory cleaned and coated outside with prime coat of rust inhibitive paint.
7. Based on Bell & Gossett Series B.

B. Air Separator:

1. Tangential flow pattern, welded steel construction, ASME stamped and rated for 125 PSIG working pressure at 350°F, National Board Form U-1A attached.
2. Connections for system inlet and outlet, expansion tank, drain.
3. Perforated stainless steel air collector tube.
4. All acceptable manufactures to submit on an air separator without a strainer.
5. Based on Bell & Gossett Rolairtrol.

C. Automatic Air Vent: Non-ferrous, automatic air vent rated for 240°F and 150 PSIG. Based on Bell and Gossett Model 87.

PART 3 - EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturers written instructions.

B. Install air vents at all high points of system to facilitate air removal for proper flow and heat transfer.

3.2 INSTALLATION

A. Pressurized Expansion Tank:

1. Isolate tank from system during system flushing and cleaning operations.
2. Vent excess air from tank prior to system heat-up.
3. Ensure that tank is properly charged with air at start of warranty period.
4. Install automatic air vent and pressure gauge at inlet.
5. Provide equipment tag indicating required charging pressure.
6. Provide drain valve and hose bibb adaptor.

B. Air Separator:

1. Support independently of connecting piping.
2. Install tap size union and gate valve with locking hand wheel in line to expansion tank.
3. Install full tap sized nipple, ball valve and plug for drain valve assembly.

C. Automatic Air Vent:

1. Install where shown on drawings or standard details.
2. Install 1/2" ball valve and nipple between automatic air vent and system.
3. Provide proper access.
4. Do not install automatic air vent in concealed or non-accessible areas or where leakage may cause damage.
5. Pipe discharge to nearest floor drain.

END OF SECTION 23 05 80

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SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Test and Balance (TAB) Contractor (shall work for the General Contractor or Construction Manager. The Test & Balance must be complete prior to substantial completion of the project.

1.2 WORK INCLUDED

A. Checking installation for conformity to design.

B. Checking each piece of equipment for proper installation and operation.

C. Balancing air and water distribution systems to provide design fluid quantities.

D. Measuring and recording of fluid quantities.

E. Electrical measurement.

F. Verification of performance of all equipment and sequence of operation of automatic controls.

G. Checking sound levels and vibration isolators for proper function and measurement and correction where a problem or question of acceptability exists.

H. Recording and reporting results on sub-contractors standard report forms and on commissioning data sheets where these have been provided.

I. If applicable, TAB contractor shall assist the commissioning agent with the commissioning of this project.

1.3 REFERENCES

A. Air Diffusion Council (ADC) 1062R3 Equipment Test Code

B. Associated Air Balance Council (AABC)
National Standards for Field Measurements and Instrumentation, Total Balance System Balance, Air Distribution - Hydronic Systems, Volume 1.

1.4 SUBMITTALS

A. Submit in accordance with Division 01 Requirements.

B. Submit complete description of procedures, instrument calibration and qualifications of personnel actually doing testing and balancing on this project prior to beginning of any balancing.

C. Submit schedules of test data readings in organized, schematic, tabulated format. Include schematic drawing showing location of all readings.

D. Submit as-built drawings showing locations of all readings.

1.5 QUALITY ASSURANCE

A. Adjusting, balancing and testing procedures and compilation of test data shall be performed by a Certified Test and Balance Engineer or by personnel trained and supervised by a Certified Test and Balance Engineer.

B. Test and balance personnel shall be qualified to perform testing and balancing in accordance with AABC or NEBB procedures.

1.6 TOLERANCES

A. Balance final air and water flow to within plus or minus 5 percent of specified quantities. Caution is urged on systems where diversity has been taken and the total flow exceeds the equipment capacity. In this case, the system must be sectioned as necessary to get proper terminal flow.

1.7 GENERAL COMMENTS

A. Water Balance: Readings from venturi flow meters or automatic pressure independent flow control devices will be given highest priority as to accuracy. Where neither is specified pump curves and chiller or boiler pressure drops are to be correlated to establish flow. Pressure drop across coils or chillers is to be used to proportion flow. Volt and ampere readings will be used as checks. Temperature data will be used only as a performance check and not for balancing.

B. Air Balance: Readings from a pitot tube traverse will be given highest priority as to accuracy. Terminal flow shall be as taken from the terminal DDC flow readings. Outlet flow as established by flow hood will be used to pro-rate air flow. Pressure readings as well as voltage and ampere readings will be used for check purposes only. Temperature readings will be used as a check against performance.

C. All readings shall be cross-checked for accuracy. These cross-checks shall be tabulated within the report.

PART 2 – PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 INTENT OF DRAWINGS AND SPECIFICATIONS

A. Review drawings and specifications with regard to adjusting and balancing.

B. Additional balancing devices which, in the opinion of the TAB sub-contractor, would aid in the adjusting and balancing of the systems shall be brought to the attention of the contractor prior to bid time so that the contractor may make allowances to cover the provision of these additional devices in the original bid.

3.2 WATER BALANCE

A. Ascertain that piping systems have been cleaned, flushed, drained and properly refilled and that all strainer baskets have been removed, cleaned and properly reinstalled prior to beginning water balancing procedure.

B. In the event that TAB work is started prior to the completion of the water treatment

portion of work, the TAB contractor shall make a random recheck as directed by the Owner's Representative. The results of this re-check shall be included in the final report.

C. Variable flow pumping systems having two-way control valves and using automatic pressure independent system of flow control for secondary chilled water systems.

1. With one pump running and all manual and automatic control valves open, record GPM stamped on each automatic flow control device and read and record the pressure drop across those which have dual pressure taps, as well as across each coil and applicable equipment.
2. With pump running as described above and all manual and automatic control valves open read and record pressure drop across each pump. Also read and record pressure drop at shut off. Plot these points on the submitted pump curves using the sum of the flow control device GPM as the total system flow.
3. Record the pump speed required to get the pressure drop across the flow control valve having the highest pressure drop to 6 PSI. If this is 85% or greater, no pump impeller change will be required. If less than 85%, the pump impeller will have to be trimmed, by the contractor and manufacturer. Advise the Owners Representative before proceeding.
4. Operate lag pump to be sure performance is the same at each step.
5. Manually set pump speed to 20% (minimum speed) and record flow and pressure difference.
6. TAB contractor shall coordinate with the BCS contractor to determine the differential pressure setpoint that is high enough to ensure design GPM through the remote cooling coil. Refer to the remote DP sensor on the drawings.

3.3 AIR BALANCE

A. Check system visually and audibly for leakage and proceed with balancing as outlined by AABC or NEBB.

B. Balance for full flow shall be based on dirty friction loss across the filters. Artificially blank-off sections on a uniform pattern as required to simulate this condition.

C. Variable Volume Systems:

1. With supply fan running at 100% speed and all terminals calling for full airflow, read and record flow and fan suction and discharge static pressure readings. Pressure readings shall be obtained using procedures outlined in AMCA Publication 203-90 Field Performance Measurement of Fan Systems. Plot on submitted fan curve.
2. Set flow at each terminal for maximum values as indicated in terminal schedule using hand held operators terminal (HHOT) furnished with the terminal controls. Provide actual measured outlet flow to temperature controls sub-contractor for setting calibration constants in DDC controls. Normally diversity is taken in the fan selection. Close other terminals as required to get full flow as required for balancing. Pro-rate terminal flow to diffusers.
3. Set minimum flow to values as indicated in terminal schedule.
4. Where applicable, adjust return fan for specified differential flow. Record fan signal fan speed and other data at full flow and at minimum flow.
5. Record all data on terminals and supply and return fan including voltage and amperage on primary air fans and return fans at full flow.

D. Constant Volume Systems:

1. Adjust each fan to deliver the specified quantity of air at the specified

temperatures to all areas of the building served by the air system. Where the installed drive cannot be adjusted to obtain the required flow, advise the contractor so that the necessary drive change can be made. Adjust speed, in direct proportion to actual vs. required cfm. Exercise caution because amps vary with the cube of speed.

2. Determine air volume in ducts by use of pitot tube, and inclined manometer. Plug all holes in duct.
3. Determine air quantity through air grilles or diffusers by use of flow hood with direct readout meter calibrated in CFM. If use of flow hood is not possible, use velometer nozzle as recommended by air device manufacturer. Calculate air quantity based on air device area factors provided by the air device manufacturer.
4. Compare duct traverse to accumulated airflow at diffusers. If the two do not reconcile, examine system for leaks and, report to contractor so that he can repair and repeat.

3.4 AIR HANDLING UNIT PERFORMANCE TESTING

A. Recognizing that it will be unlikely that the performance testing will be done on a design day, cooling and heating coil performance shall be recorded as follows.

1. With fan delivering design air flow and control valves open to deliver design water flow, read and record entering and leaving dry-bulb and wet-bulb temperatures, air and waterside flow, pressure loss values and water temperatures.
2. Through the contractor, request performance data from the equipment supplier based on the measured air flow and entering air temperatures and measured water flow and entering water temperature. Submit this data with test data for review.

3.5 REFRIGERATION SYSTEM PERFORMANCE TESTING

A. Recognizing that it will be unlikely that the performance testing will be done on a design day, refrigeration system including heat rejection equipment performance shall be recorded as follows.

1. With pumps delivering design water flow, read and record entering and leaving water conditions, pressure losses, evaporator and condenser temperature and pressures, oil pressures and temperatures and compressor motor KW or amps.
2. Through the contractor, request performance data from the equipment supplier based on the measured flow, leaving chilled water temperature, entering condenser water temperature or condensing temperature and calculated tonnage. Submit this data with test data for review.
3. With heat rejection equipment delivering design air flow, read and record entering and leaving air dry-bulb and wet-bulb temperatures and air flow, water temperature and condensing temperatures as appropriate.
4. Through the contractor, request performance data from the equipment supplier based on the measured air flow and entering air temperatures and measured water flow and entering water temperature. Submit this data with test data for review.

3.6 CONTROLS ADJUSTMENT

A. Check the automatic temperature controls to ascertain that the specified sequence of operation is occurring. Record thermostat set point and room conditions in each space. This includes checking each terminal box to ensure that supply air goes to minimum

position before heat comes on.

B. Compare temperature of space (taken with test instrument) to temperature read by thermostat or temperature sensor. Tabulate results.

C. In cooperation with the controls contractor, set adjustments of automatically operated dampers to operate as specified, indicated, and / or noted.

D. Check all controls for proper calibrations, and list all controls requiring adjustment by control installers.

3.7 CONTRACTOR'S RESPONSIBILITIES

A. Final testing and balancing of the HVAC systems shall be performed as specified in this section. It is the responsibility of the Contractor to be completely familiar with all the provisions and responsibilities of the Balancer, and to provide such certification, cooperation, and support required.

B. The Contractor shall repair all deficiencies noted by the Balancer in a timely manner. The Balancer will notify the contractor in writing, on a daily basis, of any deficiencies discovered and Contractor will notify the Balancer immediately, in writing, upon completion of the repairs. The cost for extra re-testing by the Balancer due to un-repaired items that were certified as repaired will be the responsibility of the Contractor. The final testing and balancing report will contain no punch list items. All deficiencies will have been corrected prior to submission of the final report. Preliminary reports are not to be submitted to the Owner.

C. The Contractor shall:

1. Allow adequate time in the construction schedule to perform the Testing and Balancing work.
2. Notify the Balancer upon commencement of work related to the HVAC system.
3. Provide required shop drawings and equipment data.
4. Provide test openings as required for testing and balancing HVAC systems.
5. Provide updated job schedule and timely notice prior to scheduled events.
6. Provide test openings and temporary end caps or otherwise seal off ends of ductwork to permit leakage testing prior to installation of diffusers, grilles, and similar devices.
7. Make preliminary tests to establish adequacy, quality, safety, completed status, and satisfactory operation of HVAC systems and components. The systems shall be free of electrical grounds and short circuits.
8. Perform duct leakage tests, in the presence of the Balancer, on all supply, return, outside air make-up, and exhaust air systems.
9. Within the intent of the contract documents, provide, at the request of the Balancer, all equipment, material, supplies, workmen, and supervisions necessary to provide a satisfactory, operating system.
10. During the test and balance period, operate all HVAC equipment as necessary to permit systems to be tested and balanced as fully operating, functional systems.
11. Work harmoniously with the Balancer, providing all courtesies normally extended to professional consultants.
12. Perform all work necessary to make ceiling plenums air-tight and functional.
13. Remove and replace ceilings as necessary to permit test and balance operations.
14. Remove and replace equipment, lights, or other items which obstruct testing and balancing operations. Where equipment, lights, or other items will interfere with

future adjustments of the HVAC system, such equipment, lights, or other items shall be relocated by the Contractor, as directed by the Architect.

15. Provide completed start-up forms on each piece of equipment.
16. Replace belts and drives as required for proper balancing. Drives shall be adjusted and aligned by the Contractor to prevent abnormal belt wear and vibration.
17. Adjust fan speed as required not to exceed RFLA of motor.
18. Open all manually adjustable dampers and test dampers for smooth, vibration-free operation.
19. Verify that all controls are installed and operating in accordance with the sequence of operation.
20. Before requesting final testing and balancing, submit signed statement that HVAC systems are installed, adjusted, fully lubricated, operating satisfactorily, and are ready for use.
21. Provide 8 hours of TAB onsite support for the commissioning agent to validate the test and balance report.

D. Duct Leakage Report: The Contractor shall make all the supply, return, outside air, and exhaust duct systems (limited to 1,500 cfm and greater) operationally air-tight, with no more than 10% leakage for duct systems rated at 2" w.c. pressure class, and 5% leakage for systems exceeding 2" w.c. pressure class.

1. Repair all duct leaks that can be heard or felt, even if the system has passed the leakage test.
2. Submit final leakage test report to the Owner, CM, and Engineer for review and acceptance.

3.8 TEST DATA SCHEDULES

A. Submit typewritten schedules of test data readings.

B. Schedules shall record the specified reading, the first reading taken and the final balanced reading for the following items.

C. Where Commissioning Forms are provided, equipment data shall be recorded on these forms for comparison with submitted design data.

D. All ductwork shall be leak tested in accordance with SMACNA HVAC Air Duct Leakage Test Manual. All duct testing shall fully comply with Florida Mechanical Code Chapter 6, Table 603. Maximum allowable leakage at any tested section shall not exceed 10% of the total air. If any of the selected duct sections exceed the specific leakage allowance, those sections shall be repaired by the Contractor and retested by the Balancer. If initial testing exceeds specification allowance, testing of all remaining duct ductwork shall be required at the Contractor's expense. All additional costs for duct leak repair and retesting shall be the responsibility of the Contractor.

E. Advise Contractor in writing of all ductwork that shall be repaired to reduce air leakage. Retest to confirm minimum allowable leakage. The cost of retest of failed systems will be the responsibility of the Contractor.

F. In the case of off season performance testing of air handling equipment and refrigeration equipment, include manufacturer's projected performance for comparison.

1. Motors:

a. Designation.

b. Nameplate HP, voltage and full load amperes.
c. RPM.
d. Motor amperes and voltage under operating conditions.
e. For belt drive applications, motor amperes and voltage under no load condition.

2. Fans:

a. Designation.
b. Nameplate data.
c. RPM.
d. Static pressure, inlet and discharge.
e. CFM from pitot tube traverse of discharge duct.
f. Final pitot tube traverse sheets showing all readings.

3. Main and Sub-main Ducts:

a. Designation and location.
b. CFM from pitot tube traverse.
c. Final pitot tube traverse sheets showing all readings.

4. Variable Volume Boxes:

a. Designation.
b. Nameplate data.
c. Static pressure, entering and leaving air.
d. CFM, maximum setting on regulator.
e. CFM, minimum setting on regulator. Note: If there is no minimum flow shown on the schedule on the drawing then the unit is to go to full shut-off at the minimum setting.
f. CFM, maximum as measured by flow hood readings on air outlets and CFM maximum and minimum measured by pitot tube traverse of discharge duct on 10% of boxes. Note: if these readings are not within ± 10% of setting on boxes advise contractor and engineer so that a decision can be made on how to proceed with the air balance.
g. Final pitot tube traverse sheets showing all readings.

5. Air Outlets and Inlets:

a. Room designation.
b. Type of outlet.
c. Design CFM.
d. Measured CFM.
e. Method of measurement.
f. All final measurement readings.

6. Pumps:

a. Designation.
b. Nameplate data.
c. GPM (unbalanced).
d. Pressure, suction and discharge (unbalanced).
e. Suction and discharge pressure with discharge valve closed (shut-off).
f. GPM (final balance).
g. Pressure, suction and discharge (final balance).
h. Pressure entering and leaving strainer.

7. Coils - Water:

   a. Designation.
   b. Nameplate data (if available).
   c. Pressure entering strainer valve and leaving flow control device.
   d. Pressure entering and leaving flow control device where two taps are provided.
   e. Temperature entering and leaving water.
   f. Static pressure, entering and leaving air.
   g. Dry bulb and wet bulb temperature, entering and leaving air (4 readings at quarter points where coils are over 20 sq.ft. F.A.)
   h. CFM over coil including all final readings used to obtain cfm.
   i. GPM from flow regulator nameplate.

8. Chillers - Air Cooled:

   a. Designation.
   b. Nameplate data.
   c. Refrigerant type.
   d. Pressure, entering and leaving chilled water.
   e. Temperature, entering and leaving chilled water.
   f. Pressure and/or temperature, evaporator, refrigerant.
   g. Pressure and/or temperature, condenser refrigerant.
   h. Total unit amperes and volts, each phase.
   i. Calculated GPM, chilled water.
   j. Calculated power, KW.

9. Air Cooled Condensing Units:

   a. Designation.
   b. Nameplate, Model No. & Serial No.
   c. Refrigeration type and operating charge.
   d. Suction pressure (PSIG).
   e. Discharge pressure (PSIG).
   f. Outdoor air inlet temperature (F).
   g. Condensing air outlet temperature (F).
   h. Air flow (CFM).
   i. Heat rejection calculation (tons).

10. Direct Expansion Cooling Coil:

    a. Designation.
    b. Nameplate data.
    c. Entering air DB (F).
    d. Entering air WB (F).
    e. Leaving air DB (F).
    f. Leaving air WB (F).
    g. Evaporative pressure (PSIG).
    h. Air flow (CFM).
    i. Load calculation (tons).

3.9 OPERATING TESTS

A. Operate systems to demonstrate that systems have been properly adjusted and balanced, and to demonstrate that the systems' performance conforms with the intent of the specifications and drawings.

B. The balancing contractor shall make available to the Owner's operating personnel a Certified Test and Balance Engineer for a minimum of 16 hours, two working days, not necessarily consecutive, with all necessary equipment to demonstrate that all systems operate as intended and that the balancing reports are accurate.

C. This demonstration will occur after the balancing contractor has submitted his reports to confirm that all systems or portions of the systems that coincide with the building's occupancy schedule, are adjusted and balanced.

D. Conduct tests with natural building heating and/or cooling loads for a minimum 4 hours duration.

END OF SECTION 23 05 93

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SECTION 23 07 00 – HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Duct Systems Insulation.

B. Piping Systems Insulation.

C. Equipment Insulation.

D. Cold Pipe Hanger Support Blocks.

E. Accessories.

1.3 QUALITY ASSURANCE

A. All products within the conditioned air stream or active plenums shall comply with the NFPA 90A Flame/Smoke rating of 25/50 and comply with UL 181 erosion limitations. Fire hazard ratings shall be as determined by NFPA-255, "Method of Test of Surface Burning Characteristics of Building Materials" - ASTM E84 or UL 723.

B. All adhesives, cements, finishes, jackets, etc., shall be UL listed or labeled for use as applied to insulation and designed specifically for use in the installation.

C. All insulation shall be installed in accordance with National Commercial & Industrial Insulation Standards (NCIA).

1.4 SUBMITTALS

A. Submit schedule indicating type of insulation, thickness, vapor barrier or coating by system and size.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

C. Submit details of insulated removable covers using the actual equipment dimensions, concrete base sizes and piping arrangements.

D. Submit in accordance with Division 01 requirements.

1.5 GENERAL REQUIREMENTS

A. Factory-applied insulation is specified under the applicable equipment Section of these specifications. It is listed here for reference only.

B. Acoustical duct liner is specified under Section 23 31 01 - Shop Fabricated Ductwork. It is listed here for reference only.

C. Packages and standard containers of materials shall be delivered unopened to job site and

shall have the manufacturer's label attached giving a complete description of the material.

1.6 DEFINITIONS

A. The term "exposed" means exposed to view in finished spaces, in equipment rooms, in fan rooms, in closets, in utility corridors, in tunnels, on roof, in storage rooms, and in other spaces as indicated.

B. The term "concealed" means concealed from view, and includes all spaces not defined as exposed.

C. The term "unconditioned" space shall mean all places where the temperature surrounding the pipe or duct has not been conditioned consistent with conditioned spaces, and shall include mechanical equipment rooms, non-active ceiling plenums, and non-accessible chases. This term shall also include conditioned spaces where the humidity levels are allowed to rise above 65% RH.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Fiberglass Insulation:

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

B. Closed Cell Elastomeric Insulation:

1. Armacell LLC
2. Johns Manville
3. Rubatex

C. Foamglass Insulation:

1. Pittsburgh Corning
2. Cell-U-Foam Corp.
3. Owner Approved Substitution

D. Insulation Coatings, Mastics, Adhesives, and Sealants

1. Foster
2. Childers
3. Pittsburgh Corning
4. Armacell

2.2 DUCT AND PIPING INSULATION AND FIREPROOFING REQUIREMENTS

A. Refer to the drawings for insulation size and type requirements. Please contact the engineer prior to bid with any questions regarding the insulation requirements.

2.3 MATERIALS

A. Duct Insulation: Blanket Fiberglass: Flexible fibrous glass, flame retardant factory laminated foil-skrim-kraft (FSK) vapor barrier, 2" stapling flange, maximum vapor

permeance of .02 perm/in., minimum density of 1.5 lb/cf, maximum conductivity per 1" thickness of .28 at 75°F mean temperature. Based on Knauf Duct Wrap.

B. Pipe Insulation (to 450°F):

1. Rigid Fiberglass: Resin bonded fibrous glass, flame retardant, factory applied all service jacket vapor barrier with self sealing pressure sensitive lap joints, molded to accommodate pipe, maximum vapor permeance of .02 perm/in. and a puncture resistance of 50 units, minimum density 4.0 lb/cf, maximum conductivity per 1" thickness of .23 at 75°F, .29 at 200°F and .43 at 400°F mean temperature. Based on Knauf Pipe Insulation.
2. Closed Cell Elastomeric (Small Pipe Sizes up to 5 Inches): Flexible, elastomeric, closed cellular, tubular molded to accommodate piping, smooth outer surface suitable for painting with vinyl lacquer type coating, water resistant, non absorbent, ozone resistant, minimum density of 4 lb/cf, maximum conductivity per 1" thickness of .27 at 75°F mean temperature. Based on Armacell LLC AP Armaflex and Self-seal Armaflex 2000.
3. Closed Cell Elastomeric (Large Pipe Sizes, 6" and Larger): Sheet type, flexible, elastomeric, closed cellular, smooth outer surface suitable for painting with vinyl lacquer type coating, water resistant, non absorbent, ozone resistant, minimum density of 4 lb/cf, maximum conductivity per 1" thickness of 2.7 at 75°F mean temperature. Based on Armacell LLC Armaflex II.
4. Foamglas: Rigid, preformed sections of 100% rigid cellular glass dimensionally complying with ASTM C585 standards, non-absorptive of moisture after immersion, water vapor permeability 0.00 perm/in. impervious to common acids (except hydrofluoric), non-combustible, 100 PSI compressive strength when capped with hot asphalt, 8.5 #/cu.ft. density, thermal conductivity 0.33 BTU-In./Hr./Sq.Ft./F @ 50°F. Based on Pittsburgh Corning Foamglas.

C. Equipment Insulation:

1. Closed Cell Elastomeric Sheet type, flexible, elastomeric, closed cellular, smooth outer surface suitable for painting with vinyl lacquer type coating, water resistant, non absorbent, ozone resistant, minimum density of 6 lb/cf, maximum conductivity per 1" thickness of .27 at 75°F mean temperature. Based on Armacell LLC Armaflex II.

2. Foamglas: Sections of 100% rigid cellular glass, non-absorptive of moisture after immersion, water vapor permeability 0.00 perm/in., impervious to common acids (except hydrofluoric), non-combustible, 100 PSI compressive strength when capped with hot asphalt, 8.5 #/cu.ft. density, thermal conductivity 0.32 BTU-In/Hr./Sq.Ft./F @ 50°F. Based on Pittsburgh Corning Foamglas.

D. Insulation Accessories: Aluminum Pipe Jacket and Fitting Covers: Jacket shall be 0.016" thick (26 gauge) embossed aluminum, sized to provide a 2" (min.) lap joint both longitudinally and circumferentially, with 3/4" min. wide x 0.015" min. (30 gauge) thick draw bands. Fitting covers shall be aluminum, 0.025" (22 gauge), min., thickness.

E. Cold Pipe Hanger Support Blocks: Lightweight, rigid, closed cell material having 100 lb/sq.in. compressive strength when capped with hot asphalt according to ASTM C240. Based on Pittsburgh Corning Foamglas.

F. Accessories:

1. Aluminum Pipe Jacket and Fitting Covers: Jacket .016" thick (28 ga.) embossed aluminum sized to provide a minimum 2" lap joint both longitudinal and

circumferentially, minimum 3/4 inch x .015 inch thick (30 ga) draw bands. Covers .024 inch thick. Required on all exposed/insulated piping located outside or within a mechanical room less than 7’-0” AFF.

2. PVC pipe jacket and fitting covers used with insulation for pipe, elbows, tees, couplings, 25/50 flame/smoke ratings, suitable for temperatures to 500°F.
3. Glass Cloth Pipe, Duct and Equipment Jacket: Glass lagging cloth, 8 oz/sy treated weight. Secure with elastomeric insulating adhesive on elastomeric insulation, for fiberglass insulation use appropriate mastic finish as recommended by the insulation manufacturer with the perm rating of the mastic equal to or less than that of the insulation it is sealing.
4. Corner angles shall be minimum 28 gauge, 1 inch by 1 inch aluminum adhered to 2 inch by 2 inch heavy kraft paper.
5. Glass tape shall be a minimum density of 1.6 ounces per square yard, 4 inch wide with a 10 x 10 thread count per inch of width. Glass cloth shall be untreated.
6. Staples shall be outward clinching type, Type 304 or 316 stainless steel in accord with ASTM A 167 or Monel® coated.
7. Wire shall be soft annealed galvanized, or copper, 16 gauge, or nickel copper alloy.
8. Closed cell elastomeric insulated finish shall be a white water based flexible, acrylic latex enamel equal to WB Armaflex finish.
9. Insulation Tape: Closed cell elastomeric insulation: 2" wide x 1/8" thick.
10. Elastomeric Insulation Adhesive: Air drying contact adhesive for securing sheets to flat or curved metal surfaces and joining seams and butt joints of elastomeric insulation. Suitable for temperatures to 180°F, dried film not to exceed 25 for flame spread and 50 for smoke development when tested per ASTM E 84-84A method.
11. Vapor Barrier Mastic: Air drying flexible water based mastic used for applying a vapor barrier joint with glass cloth at insulation joints. Suitable for temperatures to 180°F, wet and dried film not to exceed 25 for flame spread and 50 for smoke development when tested per ASTM E 84-84A method. Maximum Perm rating of 0.08. , Childers Products Company, Inc. CP-35 Chil Therm® WB, Foster Products Corp. Product Data 30-80 Foster Vapor Safe® Coating, Marathon Industries, Inc. 590 LO-PERM, Richard’s Paint Manufacturing CO., Inc. VBM-4, Vimasco Corp. 749 Vapor-Blok, or equal.
12. Acrylic Latex Finish and Sealers:

    a. Elastomeric Insulations: Air drying flexible water based finish used for finishing flexible elastomeric insulation. Suitable for temperatures to 180°F, wet and dried film not to exceed 25 for flame spread and 50 for smoke development when tested per ASTM E 84-84A method. Armacell LLC WB Armaflex finish.
    b. Foamglass Insulation: Air drying flexible water based sealer used for applying a vapor barrier seal over microscopic cracks that develop in the insulation. Suitable for temperatures to 180°F, wet and dried film not to exceed 25 for flame spread and 50 for smoke development when tested per ASTM E 84-84A method. Maximum Perm rating of 0.08. , Childers Products Company, Inc. CP-35 Chil Therm® WB, Foster Products Corp. Product Data 30-80 Foster Vapor Safe® Coating, Marathon Industries, Inc. 590 LO-PERM, Richard’s Paint Manufacturing CO., Inc. VBM-4, Vimasco Corp. 749 Vapor-Blok, or equal.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Install all insulation in strict accordance with the manufacturers written installation instructions.

B. Provide a PVC jacket on all exposed rain leader piping, including but not limited to the Gym. In back of house and Mechanical rooms, jacketing is required only up to 7’-0” AFF.

C. All insulation work shall be performed by skilled mechanics regularly engaged in the insulation trade.

D. Properly coordinate the insulation work with the other trades so that installation is performed with a minimum of conflict.

E. Insulation shall not be applied on any piping or duct system requiring testing until testing is completed and approved by Engineer of Record.

F. Insulation shall not be applied until all systems are clean, dry, free of dirt, dust or grease.

G. The finished installation shall present a neat and acceptable appearance which includes but is not limited to: all jackets smooth, all vapor barriers sealed properly, no evidence of "ballooning" of the jackets, or sagging insulation, all valves, dampers, gauges, unions, etc. accessible. The Owner's Representative shall be the final judge of acceptance of workmanship.

H. All equipment nameplates on hot equipment shall be left uncovered. All equipment nameplates on cold equipment shall have a removable section sized to expose the name-plate. This section shall be clearly marked "NAMEPLATE".

I. If proper maintenance procedures require access to the insulated equipment removable panels, sections or covers shall be provided to accomplish this. These access devices shall be constructed in a manner to assure easy access and sturdy construction. The contractor shall assume the responsibility to coordinate all equipment requiring insulation to be either factory or field insulated.

J. Insulation and accessories shall be applied only at suitable application temperature and conditions as recommended by the manufacturer. Do not apply insulation to any surface while it is wet.

K. Insulation shall be protected from moisture and weather during storage and installation.

L. Insulation which has sustained moisture damage, torn jackets, or other damage due to improper storage or other reasons shall not be used. If evidence of this is sighted the Owner's representative reserves the right to require the insulating contractor to remove any and/or all insulation until the Owner's Representative is satisfied that there is no longer any inferior insulation installed on this project.

M. Insulation, fabric and jacketing shall be protected from damage during construction. Damage by the insulator shall be repaired without cost to the Owner. Damage by others shall be reported in writing to the contractor.

N. The insulation subcontractor is responsible for proper material storage at the work site.

O. Work performed prior to receipt of approved documents or submittals, which later proves to be incorrect or inappropriate, shall be promptly replaced by the contractor without cost to the purchaser.

P. Insulation shall not be installed until adequate access and clearances at control mechanisms, dampers, sleeves, columns and walls have been provided.

Q. All insulation at handholes, access doors or other openings, and adjacent to flanges and

valves shall be neatly finished where exposed to view.

R. All materials, accessories and methods of installation and fabrication are subject to the Owner's Representatives inspection and approval during any phase of the work.

S. The insulation subcontractor shall prevent the accumulation of insulation debris in the buildings and on the premises of the Owner.

T. The insulation subcontractor shall be responsible for his own safety program at the work site, and shall provide instruction on safe practices for his workers assigned to the project. All employees are subject to the work rules at the job site.

U. The insulation subcontractor shall familiarize himself with the progress and execution of the job and notify the proper parties of interferences and any problems with the proper installation of his materials.

3.2 INSTALLATION

A. Duct Insulation:

1. General:

a. Insulate or internally line all flexible duct connectors equal to or greater than adjacent insulation thickness.
b. The tops of all diffusers shall be insulated same as connecting ductwork to prevent condensation.
c. Duct insulation at fire dampers shall be extended over supporting angle iron and sealed to wall.

2. Blanket Fiberglass Insulation:

a. Insulation shall be tightly wrapped on the ductwork with all circumferential joints butted and longitudinal joints lapped 2 inches and stapled. Joints shall be finished with two coats of approved vapor barrier mastic, reinforced with glass cloth extending 2 inches onto adjacent insulation. One coat of mastic shall be applied to the insulation prior to the application of the glass cloth, which shall be embedded in the mastic to ensure complete adhesion of the cloth. Additionally secure insulation to bottom of rectangular ducts over 24 inches wide with weld pins at no more than 18 inches on center.
b. Insulation shall be butted with facing overlapping all joints shall be finished with two coats of approved vapor barrier mastic, reinforced with glass cloth extending 2 inches onto adjacent insulation. One coat of mastic shall be applied to the insulation prior to the application of the glass cloth, which shall be embedded in the mastic to ensure complete adhesion of the cloth. Breaks, punctures, pin penetrations in facing shall be sealed with vapor barrier tape and vapor barrier adhesive.

3. Rigid Fiberglass Insulation:

a. Use boards in largest possible size to minimize seams. Do not use "scraps".
b. Shall be installed in all non-public exposed areas up to 10’-0” above finished floor.
c. Provide corner angles where insulation is subject to harm.
d. All fasteners shall be non-corroding.
e. The insulation shall be applied by use of cup head weld pins. Such

fasteners shall be spaced in accordance with NCIA recommendations, where NCIA standards do not address exact dimensions, cup head weld pins shall be spaced on 12" centers. Pin caps shall be covered with a round vapor seal patch that matches the jacket on the ASJ board. On cold ducts, these shall be coated so as to not cause condensation.

f. Ducts having sharp bends shall have the insulation scored as required to conform to the curved surfaces to provide a neat and acceptable appearance when finished.

g. Insulation edges and joints shall be finished with two coats of an approved vapor barrier mastic, reinforced with glass cloth extending 2 inches onto adjacent insulation. One coat of mastic shall be applied to the insulation prior to the application of the glass cloth, which shall be embedded in the mastic to ensure complete adhesion of the cloth.

h. Generally, rigid fiberglass material will only be used in finished or exposed areas, and it is intended that the finish present a neat and uniform appearance as to color and workmanship.

i. In finished areas, molded glass fiber insulation shall be used to insulate round ducts where commercially available sizes can be used.

j. Fittings on round ducts in finished areas shall be covered with premolded fiberglass fitting insulators equal to Insul-Coustic where sizes are available. For sizes where premolded fittings are not available use miter-cut segments of molded pipe insulation, wired in place, with all joints sealed with adhesive and smoothed out with a coat of insulating cement.

k. On cold ducts, the fittings shall be finished with two coats of approved vapor barrier mastic, reinforced with glass cloth extending 2 inches onto adjacent insulation. One coat of mastic shall be applied to the insulation prior to the application of the glass cloth, which shall be embedded in the mastic to ensure complete adhesion of the cloth. Hot ducts shall be finished in a similar manner, except the mastic need not be of the vapor barrier type.

B. Pipe Insulation:

1. General:

a. All locations where the insulated surface is supported by hangers, the insulation shall be protected by shields or saddles properly skimmed to maintain a smooth outer surface, and proper insulation thickness. Chilled water piping, 3" and over shall have a section of foamglas insulation installed between the pipe and shield. 3 and 4" to be 12" long, 5" and 6" to be 18" long and 8" and over, 24" long. If the possibility exists that the hanger may conduct the temperature of the conveyed medium and thus cause condensation or personal injury due to high temperature, the hanger shall also be insulated. Joints between foamglas and pipe insulation shall be properly sealed.

b. All devices connected to or in line with the piping system shall be insulated greater than or equal to the connecting piping. This includes but is not limited to valves, air separators, expansion tanks, control valves, control devices, gauge connections, thermometer stems, chemical feed equipment, piping flexible connectors, etc. This is particularly important on ice water and refrigerant lines.

c. Insulate exterior surfaces of all anchors and guides for chilled water piping systems.

d. A complete moisture and vapor barrier shall be installed wherever insulation is penetrated by hangers or other projections through insulation and in contact with cold surfaces for which a vapor seal is specified.

e. Cover fittings, flanges, unions, valves, anchors, and accessories with premolded or segmented insulation of the same thickness and material as the adjoining pipe insulation. Where nesting size insulation is used overlap pipe insulation 2 inches or one pipe diameter. Fill voids with insulating cement and trowel smooth. Elbows shall have not less than 3 segments per elbow. Secure insulation with wire or tape until finish is applied. Blanket inserts in lieu of premolded or segmented insulation is not allowed. Cover fittings with preformed PVC fitting covers.
f. Wrap all pressure gauge taps, thermometer wells and all other penetrations through insulation with closed cell insulation tape so as to prevent condensation.
g. Seal all raw edges of insulation.
h. For piping supported by hangers outdoors, apply a rainshield to prevent water entry.
i. Provide removable and re-useable covers on chilled water piping strainers to allow for removal and replacement of strainer baskets without damage to the insulation.

2. Rigid Fiberglass:

a. Provide PVC fitting covers for all fittings.
b. Align all jacket seams.
c. Assure all vapor barriers are properly sealed.
d. Provide PVC jacket over all exposed insulation in the equipment room.
e. All corner angles below 6’-10” shall have padded insulation and be marked with yellow stripes.

3. Closed Cell Elastomeric:

a. All joints shall be sealed with adhesives.
b. Where the thickness is to be obtained by use of two layers of insulation, install with staggered joints.
c. Finish:

1) Concealed Indoors: No additional finish.
2) Exposed Indoors: Provide PVC jacket over all insulation.
3) Concealed Indoors: Provide PVC jacket over fittings fabricated from insulation sections or sheet.
4) Outdoors: Provide aluminum pipe jacket.

4. Foamglas:

a. All joints, both longitudinal and circumferential shall be sealed with a vapor barrier mastic.
b. Thickness shown for refrigeration pipe to be obtained by use of two layers of insulation with staggered joints.
c. Finish:

1) Exposed Indoors: Provide PVC jacket over all insulation that shall be sealed with an acrylic latex finish.
2) Concealed: Provide PVC jacket over fittings fabricated from insulation sections or sheet. Provide ASJ over all other.
3) Exposed Outdoors: Provide acrylic latex finish and aluminum pipe jacket.

C. Equipment Insulation:

1. Vessel and Large Pipe Insulation:

    a. Insulation shall be of the same material as the piping which serves it and it shall be layered to obtain the required thickness. Maximum of 1-1/2" thick per layer.
    b. All joints shall be staggered to avoid thermal gaps.
    c. Sheet size shall be as large as possible to minimize seams. Do not use "scraps".
    d. Securing shall be by welded studs and/or non-corrosive banding wire. Do not weld brackets, clips or other devices to ASME coded pressure vessels or piping. Insulation pins or studs shall be as specified and installed in accordance with NCIA standards.
    e. Finish shall be with PVC jacket or galvanized steel mesh wire and a finish coat of insulating cement minimum of 1/4" thick. After cement has cured apply glass lagging cloth and proper coating as directed by manufacturer. All corners shall have metal corner beads and provide acrylic latex finish.

2. Removable Covers:

    a. Equipment specified to have removable covers shall have insulation as specified in Paragraph 2.4, fastened to the inside surfaces of a 20 gauge galvanized sheet metal equipment cover.
    b. The covers shall be of a sectionalized design, and shall be custom-fitted around each piece of equipment. For ease of removal, joints between sections shall coincide with the splits or joints in the equipment. Joints between sections of the cover shall be held together with quick-connect trunk latches, and shall be gasketed to form a vapor-tite seal cover (for the passage of pipes, etc.) shall be provided with closed cell elastomeric collars to ensure a tight fit.
    c. The box shall be fitted around each piece of equipment and split for removal to coincide with the split in the casing. The sections of the box shall be held together with quick disconnect trunk latches. Joints between box sections shall be gasketed to form a vapor seal. Void spaces in the box shall be packed with flexible fiberglass insulation. Openings around pump casing shall be provided with closed cell elastomeric collar to ensure tight fit.
    d. Provide acrylic latex finish.
    e. Coordinate the piping of the drain, vent, gauge, and control lines to exit through the base or back section of the removable cover. The insulation of these pipes shall be totally independent of the removable cover.

3. Chilled Water Compression Tank and Filtering Systems: Surfaces shall be insulated with 1 inch thick closed cell elastomeric insulation board or pipe insulation, as applicable. Finish as specified for vessel and large pipe insulation.

D. Cold Pipe Hanger Support Blocks:

1. Provide on all chilled fluid systems pipe hangers and supports.
2. Apply Pittcote 404 or approved equal, acrylic latex mastic filler over insulation and on ends.
3. Apply Pittseal 444 or approved equal, butyl joint and penetration sealant at joint between foamglas and adjacent insulation.
4. Provide vapor barrier system to match the vapor barrier on the adjacent system.
5. Provide 20 gauge (min.) galvanized shield between the insulation and the hanger or support.

E. PVC Jacket:

1. Provide PVC sheet jacket over all exposed, indoor piping or insulation.
2. Provide PVC pipe jacket over all exposed, indoor foamglas or elastomeric pipe insulation.
3. Provide PVC fitting covers over all fittings fabricated from insulation sections or sheet material.
4. PVC pipe jacket shall be applied with special attention given to achieving positive seal at all longitudinal and circumferential joints using a welding solvent on the longitudinal joint as recommended by the manufacturer. Slip joints to have 4" minimum lap and no welding solvent.
5. ASJ is acceptable for chilled water piping within the mechanical rooms, per Owner accepted VE.

F. Glass Cloth Jacket:

1. Provide where specified.
2. Provide acrylic latex finish.

G. Flexible Acrylic Latex:

1. Apply two coats to glass cloth jacket, concealed foamglas and closed cell elastomeric insulation.
2. Refer to Division 09 for color to be used. If no instructions are given, provide a white finish.

3.3 MISCELLANEOUS ITEMS

A. General: Provide insulation of any portion of a system or piece of equipment not previously discussed where ambient operating conditions will allow condensation to occur or whose surface temperature exceeds 115°F. Insulation materials and method shall be as directed by the Designer.

B. Final Inspection: At final inspection, the finished surfaces of all exposed insulation shall be clean and without stains or blemishes. Repair and clean the insulation surfaces and, if necessary, to obtain a new appearance, shall coat discolored surfaces with off-white latex water-base semi-gloss paint or lagging adhesive, without a change in the contract price.

END OF SECTION 23 07 00

SECTION 23 09 23 – INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

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. The following specifications are also related to this section:

1. Specification Section 23 05 18 – Control Wiring
2. Specification Section 23 05 93 - Testing, Adjusting and Balancing for HVAC Systems.
3. Specification Section 23 09 93 - Sequence of Operations for HVAC Controls.
4. Section 23 33 00 - Air Duct Accessories
5. Section 23 36 00 – Air Terminal Units.
6. Division 26 - Electrical

1.2 WORK INCLUDED

A. Complete stand alone, open protocol Direct Digital Control (DDC) BACnet Building Control System (BCS) including all control devices, valves and dampers.

B. Complete system of control and interlock wiring including wiring specified in Section 23 05 18 -Control Wiring and Section 23 09 93 - Sequence of Operations for HVAC Controls.

C. Interface with Product Integrated Controls specified in other sections of the specifications.

D. Chiller Control Panel Interface: Provide all necessary programming and setup to provide direct communication to chiller manufacturer’s BACnet translator software to provide the chiller commands, points, and diagnostic messages as specified in the points list and sequence of operations. The contractor will coordinate all requirements with the various chiller manufacturers prior to bid and include all costs necessary to provide the chiller data through the BAS network including to the Owner’s remote operator computer.

E. This section also includes Web Based Open Protocol DDC building network controllers and Equipment controllers that are open protocol utilizing BACnet protocol for the purpose of controlling HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory wired controls, lighting in new and existing facilities.

F. Access to the controls shall be through an owner provided IP address with use of a user ID and password. Contractor to provide a web server as part of the contract.

1.3 QUALITY ASSURANCE

A. The installation of the building control system shall be by the manufacturer of the controls or his local authorized agent who has a minimum of five (5) years of representation in this County.

B. All electrical components 25 V and above shall be U.L. listed or labeled.

C. All equipment or piping used in the conditioned air stream, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable local building codes or requirements.

D. All wiring shall conform to the National Electrical Code (NEC).

E. All smoke dampers shall be rated in accordance with UL 555S.

1.4 DEFINITIONS

A. Control Wiring: All wiring, 120 VAC or low voltage other than power wiring, required for the proper operation of the mechanical system.

B. Power Wiring: All line voltage wiring to the mechanical equipment. Note: Where line voltage serves a control circuit such as power to a transformer, power to a DDC control panel, power for a line voltage thermostat, or damper this shall be considered control wiring.

1.5 SUBMITTALS

A. Submit in accordance with Division 01 Requirements.

B. Provide complete catalog data and installation instructions for each control component. Include damper and valve sizing details.

C. Control system submittal shall contain the following graphics and documentation for each system being controlled:

1. Communications bus schematic showing all panel locations and hardware requirements.
2. Schematic wiring diagrams in ladder form for each system including power source.
3. Schematic diagram with detail of all hardware, components used, location of instruments, bulbs, dampers, valves and other components. The chart shall include control chart including control symbols, quantity, manufacturer's part number, tech sheet reference (include in submittal) and description of part.
4. Each DDC field panel shall be detailed in the submittal to identify termination boards within each panel and terminal of their respective field points. Each termination point shall define the point name and point description by each terminal with the field panel. Point names and descriptors shall be consistent throughout the submittal on the schematics, wiring diagrams, equipment list, etc.
5. Submit the system architecture or configuration complete with all processors, terminals, other peripheral devices, etc., with interconnecting diagrams.
6. A report shall be included in the submittal to include every point in the entire system. The report shall include the programmed data for each point:

    a. Point Name
    b. Point Type (analog, digital, etc.)
    c. Point Descriptor
    d. Physical Address (enclose legend)
    e. Alarm (yes or no)
    f. Print Alarm (yes or no)
    g. High Limit
    h. Low Limit
    i. Totalized (yes or no)
    j. Hours or Minutes Totalized
    k. Engineering Unit of Point

7. A flow chart form of sequence of operation in abbreviated English language.
8. English language sequence of operation defining flow chart with the control

company programmed inputs to reflect English language sequence. Each sequence task shall be followed by the control company coded program. One list of coded programmed inputs at the end of each sequence of operation shall be acceptable.

D. For each Direct Digital Control (DDC) panel provide:

1. Point List identifying each input and output by point name, point type, hardware description, wiring terminations, mounting arrangements and software features.
2. Complete English language description of all software.
3. Flow diagram and complete details program.

1.6 CONTROL SYSTEM GENERAL REQUIREMENTS

A. The control system shall be of the electronic microprocessor type employing Direct Digital Control (DDC) Open Protocol technology BACnet technology for all control sequences unless specifically stated otherwise in the Sequence of Operation portion of this specification.

B. All DDC controllers shall be connected via a communications bus to an operator’s panel. The operator’s panel may be located on the face of one of the DDC controllers, or at an alternate location as approved by the Engineers. In addition, a portable operator’s panel may be connected to the system at any DDC controller location.

C. All DDC controllers shall be connected to a global information handler, which shall send and receive information of a global nature throughout the system. The information handler shall allow each DDC controller and operators panel access to all information contained within the system, regardless of location. The information handler shall also allow commands from any DDC controller or operators panel to be directed to any other DDC controller on either a global or individual basis. The information handler may be furnished as an integral part of one or more DDC controllers. This “Building Network Controller” shall be an Open protocol controller that will allow the simultaneous communication to BACnet communication residing on the lower tier controllers (equipment controllers). The building controller shall be capable to be accessed using the majority of internet open protocols such as JAVA, XML, HTTP, Etc.

D. Provisions shall be made to allow additional DDC controllers to be added at any point on the communications bus for future expansion.

E. Field Installed Devices (FID) shall be capable of stand-alone operation, as well as interfacing with the networked Building Control System. These controllers shall be BACnet Protocols. No other protocols for this section will be acceptable.

F. Valve and damper operators shall be of the electronic type.

G. The Building Control System shall be made up of HVAC equipment with factory installed microprocessor-based Product Integrated Controls (PIC), distributed microprocessor-based Field Installed Devices (FID), input/output modules and necessary software.

H. The Product Integrated Controls (PIC) shall be factory installed controls capable of stand-alone operation. The controller shall be specifically designed to operate and monitor the functions of the HVAC equipment on which it is installed. The PIC shall be capable of interfacing onto the network.

I. The Building Network Controller shall incorporate the GUI (Graphical User Interface) via a standard web browser. Use of hardware keys or special licenses requirements to

access the system with a browser is unacceptable. The Building controller will serve up the web pages on a standalone per building application for the intent that if the WAN is not working, an operator can access the system on site via the building internal network using an IP. A server computer will be located at the energy management office to supervise the remote panels and alarm if the communication is lost as well as any control function alarm. This server computer will also be the area of trending archives. See the specification section 2.3, B, 7

1.7 INTENT OF DRAWINGS AND SPECIFICATIONS

A. The implied and stated intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment and workmanship and to provide a complete and operable building control system.

B. The drawings are diagrammatic intending to show a workable general arrangement and location of system components and are not necessarily complete or rigid in all details.

C. Deviation in the detailed building control system due to the inherent differences in alternate control systems will be allowed provided the intent and minimum quality standards detailed and specified are maintained.

D. No deviation in the specified sequence of operation, as specified in Section 23 09 93, Sequence of Operations for HVAC Controls, will be allowed without written approval from the Engineer.

1.8 OPERATION AND MAINTENANCE MANUALS AND INSTRUCTIONS FOR OWNER

A. Operation and maintenance manuals shall be provided as outlined in Division 01 Requirements. The manuals shall include all data which was a part of the original submittal with as- built wiring diagrams, parts lists and operating and maintenance instruction manuals.

B. A total of 40 hours of on the job owner training conducted by a technician or technicians fully qualified to conduct such training shall be provided. Instruction or Training shall include, but not be limited to:

1. Instructions in the manufacturers recommended maintenance and operating procedures.
2. Instructions in the detailed sequence of operation of the mechanical equipment controls.
3. Instructions in reading and using the control wiring diagrams.
4. Instructions in control setpoint adjustment as relating to each specific system provided under this section.
5. Performance testing as described in Part 3.

1.9 COOPERATION WITH OTHER CONTRACTORS

A. The Building Control Sub-Contractor shall coordinate with other trades to assure a complete and operational Building Control System.

B. This contractor shall furnish to the air balance contractor (Section 23 05 93 - TESTING, ADJUSTING AND BALANCING FOR HVAC) a notebook PC computer for terminal box set-up. At the completion of the balancing, the terminal shall be turned over to the owner.

1.10 MATERIALS, STORAGE AND HANDLING

A. All components shipped to the job-site and stored on-site shall be stored in a clean, dry storage location.

1.11 WARRANTY

A. Provide a 1 year warranty of the parts (hardware & software) and labor from substantial completion. Refer to “Software Enhancements” for upgrades required for the first FIVE years of operation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Alerton – BACTalk

B. KMC

C. MC^2

D. Trane

2.2 EQUIPMENT

A. Direct Digital Control (DDC) Controllers (wireless controls are NOT acceptable):

1. Direct Digital Control (DDC) Controllers shall be field programmable microprocessor based, electronic controllers incorporating direct digital control technology. The DDC controllers shall be capable of performing their assigned control and energy management functions as stand alone units or as part of a comprehensive Building Management System. The controllers shall be capable of performing energy management functions including, but not limited to supply air and water reset, economizer, duty cycling, chiller optimization, morning cool-down and warm-up, solar compensation, unoccupied setback, and real-time scheduling.
2. The BCS main controller shall be connected to the premise distribution system data network.
3. The controllers shall have built-in, non-volatile, real-time calendar clocks capable of generating real and elapsed time signals in years, months, days of the week, hours, minutes and seconds, as well as elapsed time in days, hours, minutes and seconds. The controller shall be provided with a minimum of 72 hour back-up capability protect against loss of time in the calendar clock and the programmed software and provide surge protection on the head end terminal.
4. The controllers shall be capable of interfacing with a standard twisted pair communication channel for local operation and shall be protected with software security code keys to prevent unauthorized access. Where practical, controllers shall be fully distributed and dedicated to an individual piece of equipment or system. When input/output requirements exceed the capacity of a controller, additional controllers shall be connected serially in a daisy chain configuration to allow for the use of a single RS485 interface channel for multiple controllers. Global level controllers shall allow full Internet Protocol (IP) communications

through a static IP connection through a 10/100 megabit per second Ethernet protocol.

5. The controllers shall be programmed for the sequences of operation defined hereinafter. The execution of these sequences shall be fully automatic and without operator intervention. The controllers shall sense all of their inputs, test for multiple input programmed conditions and execute appropriate action on valves, dampers, pumps, fans and other equipment. The programmed conditions may include any combination of inputs, outputs, time and the mathematical operations (addition, subtraction, greater than, less than, square root, or absolute value). Program changes shall be entered into the controllers without interruption of the system operation.
6. The controllers shall be completely field programmable from a laptop unit or from a remote location through web based access. The program logic shall allow changes without interruption of the system operation.
7. The controllers shall be programmed to examine their inputs for emergency conditions and to automatically initiating the actuation of the appropriate alarm mode.
8. The operator, through a terminal, shall be capable of overriding the programmed control sequence to manually operate the outputs for system checkout. All sequences of operation shall be demonstrated through this simulation technique. The controllers shall be stepped through their sequence to verify system operation. During the maintenance routine, the controllers shall be capable of selectively disabling inputs and outputs without affecting the operations of the remaining inputs and outputs. The controller’s status shall be accessible through the ASCII channel. Upon appropriate commands, the controller shall read out time, analog input values, output status, program line number being processed, disabled inputs, disabled outputs and sequencing program logic. Through the ASCII channel, the controllers shall be capable of printing a data history log for maintenance and trouble shooting of the system.
9. The controllers shall have a minimum of four levels of access available for terminal operation of the unit. The number of functions allowed an operator shall be determined by the level of password that is correctly entered into the controller.
10. The executive operating system provided with the controllers shall provide for all the functions described herein. The executive system shall provide English error messages to the user when any command or date is entered that cannot be understood by the microprocessor. An editing system shall also be provided for program entry. A program and variable trace routine shall also be provided to allow for easier program testing and debugging.
11. Digital Controllers used to control terminal equipment, such as variable volume boxes, shall be designed as individual control units. All variables shall be capable of being viewed and changed from the operator’s panel, or the portable operator’s console.
12. Digital Controllers used to control variable air volume (VAV) and fan powered VAV boxes shall include:

    a. Pressure independent air volume controller capable of controlling air volume within 5% of design air volume from minimum to maximum flow and at all points in between regardless of changes in system static pressure. Air volume maximum and minimum to be factory set and field re-adjustable. Controller shall be capable of 3 set positions: Off, Minimum and Maximum with VAV control from the min. to the maximum position. Minimum air volume shall be accurately controlled as low as 100 FPM based on inlet duct size. Maximum and minimum air volumes as scheduled on the drawings. If special multi-point velocity sensor is required to meet the specification, this supplier to furnish and coordinate

installation with terminal supplier.

b. 24 VAC damper actuator. NC control operation as specified.
c. Digital output for fan control.
d. Digital outputs for each step of electric heat control.
e. Temperature sensor.
f. A factory calibrated damper assembly and multi-point velocity sensor is specified to be provided with VAV terminals under Section 23 36 00 – Air Terminal Units. Provide 24V power source and wiring to terminal controller on VAV units which do not have a fan under this division, and in addition, a 24V, 40VA control transformer will be supplied on fan powered units by the terminal manufacturer. This supplier shall coordinate all requirements with the terminal supplier.

B. Operators Communications: Communication with school BAS shall be possible via an Owner provided IP address and use of a User ID and password from any District computer. Software installation to access controls is not acceptable. All manufacturers must provide a web server.

C. Input-Output Devices:

1. Temperature Sensors:

a. Temperature sensors shall be provided for space, duct, fluid, and outside air sensing which are compatible with the digital controllers. All temperature sensors shall be accurate to .36°F over a range of -30 to 220°F and shall have a demonstrated stability of .04°F over a 10 year period.
b. Temperature sensors shall be 10K resistor style.
c. All sensors in water lines to be installed in wells. If a permanent thermometer is not located at sensing point, a second well will be installed adjacent for temperature verification purposes.
d. All sensors for cooling or heating coil leaving air temperatures shall be serpentine type across entire coil surface area. Sensing tube type is not acceptable.
e. Room temperature sensors in public spaces (Auditoriums and Gymnasiums) shall have concealed setpoint adjustment with blank covers.
f. Room temperature sensors in private offices and classrooms shall have user accessible setpoint adjustment with setpoint indication and space temperature indication with adjustable minimum and maximum setpoints capability with digital read outs.

2. Humidity Sensors:

a. Electronic Humidity Transmitters: Electronic humidity transmitters shall produce a linear 4-20 ma signal over a range of 0 to 100% RH. Accuracy shall be □2% of full scale.
b. Single point calibration.
c. Shall be either VAISALA HMD-60U for duct applications and VAISALA HMW-60U for wall mounted applications or Veris.
d. Room Humidity sensors shall be integral to the room temperature sensor so that there is only one sensor per room.

3. Pressure Sensors: Electronic static and differential pressure transmitters shall be stainless steel diaphragm type, with a variable capacitance electrode to produce a linear signal over the appropriate input range. Input ranges shall be

available from 0.1 in. H_2O to 7.5 in.H_2O and transmitters shall be selected for 150% of the design pressure. Both zero and span shall be field adjustable. Accuracy shall be ±1% of full scale over the selected range, wherever differential pressure transmitters are subject to damage by disconnecting pressure lines, provide three valve manifolds for disconnection and testing. Provide an LCD display.

a. Based on Setra Model C239 and the DPT Setra Model 231 (no substitutions).
b. Chiller DPT Based on Dwyer Mercoid Series 3100 (no substitutions).

4. Valves and Operators:

a. Isolation Type Valves:

1) 2" and smaller: Ball style, sized for minimum pressure drop.
2) 2-1.2" and larger: Butterfly style, sized for minimum pressure drop.

b. Control Valves:

1) Valves shall be provided with equal percentage modulating plugs, renewable composition disk especially compounded for hot or cold water service to assure tight seating. Three-way valves shall be furnished with modulating type plug assemblies and shall have one seat machined integral with the body and the other three-way valve end.
2) Valves shall be sized as indicated or as required to guarantee sufficient size to meet the heating or cooling requirements with specified pressure drops. Water valves shall be sized for 2 psig minimum and 5 psig maximum pressure drop. Valves 2 inches and smaller shall be screwed and valves 2-1/2 inches and larger shall be flanged.

c. Valve operators:

1) Shall be gear driven electronic. Operators shall be of sufficient size to ensure smooth positive, operation and tight shut-off against system pressure.
2) Electronic operators shall be of the positive gear driven type using a brushless DC motor with built-in mechanical stops and electronic current limiting circuit to prevent burn-out. The drive motor shall be microprocessor controlled and capable of accepting a 4-20 mA, 0-10 V DC, 0-20 V Dc phase-cut, on-off, or floating tri-state control signal as required. Based on Belimo Aircontrols (USA), Inc.
3) The source of power for valve operation, electronic shall be the responsibility of the BCS Contractor.

5. Butterfly Valves and Operators:

a. Isolation valves and control valves 4" and over may be butterfly type.
b. Valves to have 416 stainless steel stem, full lug, cast iron or ductile iron body to permit removal of downstream piping, long neck body extended to allow for a minimum of 2" insulation, aluminum bronze or stainless steel disc, bubble tight EPDM seat, infinite position throttling, Class 150,

20°F to 220°F range.

c. Where three way valves are shown, factory furnished T-assemblies with mounted valves and cross linkage may be used.

d. Valves to have gear driven electronic operators. Operators to be of sufficient size to ensure smooth, positive operation and tight shut-off against system pressure. Preheat coil valves and valves on the primary and secondary heating water circuits shall have spring returns. The water valves shall be designed to go to the open position on power or other failure.

e. The source of power for valve operation, electronic shall be the responsibility of the BCS Contractor.

f. Based on Keystone Fig. AR2.

6. Dampers and Operators:

a. Outside, return, relief and exhaust air dampers shall be low leakage proportion/air type, and shall have a leakage of less than 1/2% when closing against 4 in. w.g. static pressure. The frame shall be 16 gauge galvanized steel hat shaped channel with corner braces. Blades shall be constructed of 16 gauge galvanized steel on 6 inch centers. Blade seals shall be EPDM and jamb seals shall be flexible metal, compression type. Fan discharge dampers and return air dampers are to be used as smoke dampers and shall be minimum Class II rated as smoke dampers per UL 555S. Air handling unit maximum outside and relief air dampers shall be opposed blade type. Return air damper shall be parallel blade type positioned to direct return air toward the O.A. damper. Each damper shall have an individual actuator and analog output. Where a minimum O.A. damper is indicated, it shall have a separate digital output.

b. Electronic operators shall be of the positive gear driven type using a brushless DC motor with built-in mechanical stops and electronic current limiting circuit to prevent burn-out. The drive motor shall be microprocessor controlled and capable of accepting a 4-20 mA, 0-10 V DC, 0-20 V DC phase-cut, on-off, or floating tri-state control signal as required. Based on Belimo Air Controls (USA), Inc., Invensys DuraDrive and Tamco.

c. Actuators for outdoor air and exhaust air dampers shall have spring return, and the dampers shall be designed to go to the closed position on power or other failure.

7. Smoke Detectors:

a. Smoke detectors (SD) will be furnished and installed by Division 26 – Electrical and Division 23 – Mechanical. (Refer to Specification Section 23 33 00 – AIR DUCT ACCESSORIES). Detectors will be required in all air handling systems greater than 2000 CFM. Detectors will be required in supply ducts of air handling units or on multi-story buildings in the return at each floor. The detectors shall be wired to shut-down the fans and indicate status to the DDC controls. In the case of an engineered smoke control system, they shall be wired to control as specified.

8. High limit thermostats (FS) shall be provided for each exhaust fan and shall be of the manual reset type. Thermostats shall be UL listed and shall be wired to shut down their respective fans should the temperature in the duct rise above 125°F (adj.).

9. Low limit thermostats (FR) shall be provided as indicated and shall be wired to shut down their respective unit should the temperature at any point on its sensing element fall below 35°F (adj.). Thermostats shall require manual reset. Provide 1 foot of sensing element for each 2 sq. ft. of duct cross section.

10. Panels:

    a. All relays and similar devices shall be mounted within Control Panels. Quantity and location of control panels shall be dictated by contractor’s system architecture.
    b. Control panels shall be dust tight and furnished with hinged locking doors. Provide an engraved nameplate on the face of the panel clearly describing its function. All devices located within the panel shall be clearly labeled. All wiring within the panel shall be in accordance with NEMA, UL standard, NEC and local codes. Details and proposed mounting location of each panel shall be submitted prior to construction. All panels shall be factory prewired and pre-piped to terminal strips prior to arrival at job site.
    c. Provide wiring diagram mounted inside door with plastic protective covering.

11. Relays:

    a. All relays shall be plugged in, interchangeable, mounted on a circuit board and wired to numbered terminal strips.
    b. Start/stop relay modules shall provide either momentary or maintained switching action as appropriate for the motor being started.

12. Differential Pressure Switches: Binary differential pressure sensors shall be used to indicate pump and fan operation and for indicating high pressure drop across filters. These sensors shall be of the diaphragm type and shall be adjustable and furnished in ranges compatible with their service.

13. Current Sensing Relays:

    a. Solid state switch which operates when current level sensed by internal current transformer exceeds the threshold value set by the adjusting device. Internal circuits totally powered by induction from line being monitored.
    b. Current range and switching characteristics as required for intended duty.

14. Line Voltage Electric Thermostats:

    b. Where mechanical equipment such as certain exhaust fans or unit heaters are indicated to be controlled directly from a space thermostat, provide a thermostat of either the heating or cooling type depending upon the application.
    c. All line voltage thermostats shall be rated to carry 125% of the load of the controlled device.

15. Thermostat/Temperature Sensor Guard: Wire guard with steel base.
16. Water Flow Meters:

    a. Flow meters shall be insertion electromagnetic type, suitable for hot tap insertion and removal as required. The meter shall mount on a 1 inch full

opening isolation valve. The meter assembly shall consist of all necessary interface electronics to transmit a compatible digital pulse train flow signal to the digital system controller.

b. Wiring installed by the contractor between the control system and the transducer shall be Belden 9320, two wire, shielded twisted cable, and shall not be included in conduit containing AC circuit wiring.
c. The flow transducer shall utilize an electromagnetic sensing flow meter with no moving parts. The flow transducer shall have an achievable accuracy of +/-1% of flow rate with flow velocities of 2 to 20 fps when installed with 10 pipe diameters of straight pipe before the transducer and 5 pipe diameters after the transducer. Provide 36” clear from pipe to top of meter.
d. The meter shall provide a single analog output for flow rate, a high resolution frequency output to drive peripheral devices, a scalable pulse output for totalization and an empty pipe alarm signal.
e. The system shall include a System-10 BTU meter for energy management and shall be mounted next to the BCS panel in the central energy plant or in a mechanical room where the meter is located.
f. Based On Onicon Model F-3500

17. Thermal Mass Flow Meters (provided by the BCS contractor for KITCHEN natural gas or propane metering at the discharge of the utility company or local purveyor meter assembly):

a. Flow meters shall be inline type (1/4” through 4” nominal pipe size). The meter assembly shall consist of all necessary interface electronics to transmit a compatible digital pulse train flow signal to the digital system controller.
b. Wiring installed by the contractor between the control system and the transducer shall be Belden 9320, two wire, shielded twisted cable, and shall not be included in conduit containing AC circuit wiring.
c. The flow sensing method for thermal mass flow is through hybrid analog/digital sensing circuitry. The achievable accuracy of +/-1% of reading from 500-7000 SFPM and +/-2% of reading from 100-500 SFPM.
d. The meter shall provide a single analog output for flow rate, a high resolution frequency output to drive peripheral devices, a scalable pulse output for totalization and an empty pipe alarm signal.
e. All wetted metal shall be 316 stainless steel.
f. Include a NEMA 4 enclosure around the device if mounted outside.
g. Based On Onicon Model F-5200 (coordinate with manufacturer based on the type of gas at each site).

18. Domestic Water Sub-Meter (provided by BCS contractor for the KITCHEN dedicated domestic water line):

a. Flow meters shall be inline type (1” through 3” nominal pipe size). The meter assembly shall consist of all necessary interface electronics to transmit a compatible digital pulse flow signal to the digital system controller.
b. Wiring installed by the contractor between the control system and the transducer shall be Belden 9320, two wire, shielded twisted cable, and shall not be included in conduit containing AC circuit wiring.
c. The meter shall provide a single analog output for flow rate, a high resolution frequency output to drive peripheral devices, a scalable pulse output for totalization.
d. Include a NEMA 4 enclosure around the device if mounted outside.

e. Based On Onicon Model F-4600.

19. Air Flow Measuring Station: Duct and plenum mounted airflow measurement devices.

a. Based On: EBTRON, Inc. Model GTx116-P (basis of design, HTx-104-P (when meeting sensor densities).

1) Tek-Air is an acceptable Vortex Shedding Alternative.

b. Alternatives requesting acceptance as “equals” less than 60 days prior to bid date or products submitted in non-conformance with the requirements of this specification will not be considered.

c. For any product to be considered for substitution a written section-by-section detailed exceptions/compliance document shall be submitted to the Engineer before any approval will be considered.

d. Any product offered as an equal to EBTRON shall make a working demo available for a side by side evaluation in the specifying engineer’s office.

e. The working demo must be able to demonstrate airflow measurement throughout the entire specified range (50 - 5000 FPM), repeatability, response time and specification compliance. Providing a working demo in and of itself does not constitute its approval.

f. Provide airflow/temperature measurement devices (ATMD) where indicated on the plans or as recommended by an authorized EBTRON representative. The fan inlet measurement devices shall not be used unless specifically indicated on the plans.

g. Each ATMD shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.

1) Each sensor node shall contain two individually wired, hermetically sealed bead-in-glass thermistors.
2) Thermistors shall be mounted in the sensor node using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment. Thermistor leads shall not be fastened to the thermistor semiconductor substrate by weld or solder connections.
3) The airflow rate of each sensor assembly shall be equally weighted and averaged by the transmitter prior to output. All integrated circuitry shall be temperature rated as ‘industrial-grade’. Submissions containing ‘commercial-grade’ integrated circuitry are not acceptable.
4) The temperature of each sensor assembly shall be velocity weighted and averaged by the transmitter prior to output.
5) Each transmitter shall have a 16-character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics.
6) Devices using chip-in-glass or diode-case chip thermistors are not acceptable.
7) Devices using less than two thermistors in each sensor assembly are not acceptable.
8) Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.
9) Pitot tubes and arrays are not acceptable.
10) Vortex shedding devices are not acceptable.

h. Duct and Plenum Probes

1) Probes shall be constructed of extruded, gold anodized, 6063 aluminum tubes or optionally of Type 316 stainless steel tubes. All internal wires within the tube shall be Kynar coated. PVC insulated conductors are not acceptable.
2) The number of individual sensor nodes provided for each location shall be as follows:

Duct or Plenum Area (ft^2)	Total # Nodes / Location	Duct or Plenum Area (m^2)
<= 1	1 or 2	<= 0.093
>1 to <2	4	>0.093 to < 0.372
2 to < 4	6	0.372 to < 0.743
4 to < 8	8	0.743 to < 1.115
8 to <16	12	1.115 to < 1.486
>=16	16	>= 1.486

3) Sensor probe design shall be capable of providing up to 8 sensor nodes per probe.
4) The minimum operating airflow range shall be 0 to 5,000 FPM (25.4 m/s) unless otherwise indicated on the plans.
5) Each ducted sensor probe shall have an integral, U.L. Listed, plenum rated cable. Cable jackets and conductor insulation shall be FEP, Teflon-FEP or Neoflon-FEP. Cables shall include a terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated. PVC jacketed cables or PVC insulated conductors are not acceptable with ducted sensor probes.

20. Carbon Dioxide Monitor - Controller:

a. CO2 sensing cell shall consist of a nondispersive infrared carbon dioxide gas cell that uses a pulse source and has no free air optical path. Output shall be linearized 4-20 mA for use with 24 VDC input. The unit shall be specifically designed for a wall application. Unit shall have span adjustment. The unit shall have no moving parts.
b. Minimum Requirements:

1) Range: 0-2,000 ppm
2) Accuracy: 3% of full scale
3) Repeatability: 1% of full scale
4) Zero Drift at Constant Temperatures: 100 ppm per 24 hours (random not cumulative)
5) Max. allowable Drift in 1 year: 20 ppm

c. Unit shall not require calibration for a period of 1 year or more.
d. Unit shall have a 5 year warranty.
e. Approved Manufactures:

1) System Integrator’s brand named product
2) Valtronics
3) Telaire
4) Veris

21. KW Meter (provided on the following equipment/locations by the BCS

manufacturer coordinated with the electrical contractor):

1. All chillers and pumps. If the main service for the entire plant cannot be monitored through one point of electrical service the KW consumption shall be totaled for all equipment within the CEP and recorded through the BCS.
2. All kitchens (equipment and lighting panels). The KW shall be monitored at both panel locations and recorded separately through the BCS.

b. Product description shall include the following:

1) Surface mounted within the pump house.
2) Provide BACnet output.
3) Provide data logging capability for protection of data in the event of a power failure.
4) Provide combinations of serial communication, pulse output, and phase alarms.
5) Provide pulse inputs to incorporate simple flow sensors to track gas, water, steam, or other energy forms using a BACnet system.

b. The Features shall include the following:

1) Revenue Grade measurements
2) Wall mounted
3) ANSI 12.20 0.5% accuracy, IEC 62053-22 Class 0.5S
4) Real energy output and phase loss alarm output
5) 90-600VAC
6) Data logging capability
7) Compatible with CTs from 5A to 32000A
8) User-enabled password protection (E5xHx)
9) BACnet MS/TP support (no gateway) with serial rates up to 115.2 kbaud (E5xHx)
10) Bi-directional metering (4-quadrant), an essential solution for solar and other renewable energy applications, measures Import, Export and net energy transfer
11) CSI approved

c. The accessories shall include the following:

1) NEMA4 enclosure and locking mechanism, required if mounted outdoors
2) Fuse Kits with hi-interrupt capability AC Fuses
3) Split-core and solid-core CTs
4) Replacement mounting clips
5) BACnet IP Router

f. Based on Veris Industries Model E5x Series

22. Smoke dampers shall be as specified in Section 23 33 00 – Air Duct Accessories.

2.3 SYSTEM SOFTWARE

A. General:

1. The Contractor shall provide all software required for efficient operation of all functions required by this specification. Software shall be modular in design for flexibility in expansion or revision of the system. The software shall, as a minimum, include:

    a. Complete database entry
    b. Configuration of all application programs to provide the sequence of operation indicated
    c. Complete graphics package, including graphics floor plans and individual graphics, for each system.
    d. Alarm limits and alarm messages for all critical and non-critical alarms
    e. Configuration of all reports and point summaries indicated

2. The system software shall be complete such that each control loop shall function as specified in the Sequence of Operation.
3. The building control system manufacturer shall be required to write the software program and test the operation of every control loop. A letter certifying that the system is ready for inspection shall be submitted to the engineer prior to the controllers being shipped to the field. The engineer may at his option visit the contractor's office and witness proper operation of each control loop prior to shipping from the contractor's point of fabrication. The control contractor shall provide a means of simulating every input to the system as a requirement for debugging the software. Prior to shipping of the microprocessor controller, the debugged software shall be transmitted to the owner for approval.
4. After all field connections have been made and control power is available in the control panel, the owner shall be notified and the control system shall be energized. Any required reloading of the software shall be performed and start-up of the mechanical system and building control system shall commence.
5. The building control contractor shall be responsible for all necessary revisions to the software as required to provide a complete and workable system consistent with the letter and intent of the specification. All control performance criteria are specified in the Sequence of Operations section of the specification.
6. After the system has operated properly for 90 days following start-up of the final component of the heating and air conditioning systems, an as-built copy of the software shall be transmitted to the owner for permanent record purposes. Any software upgrading or enhancements to improve the system operation or as required for proper operation of the system during the first year of operation is the responsibility of the building control system contractor. Any changes to the software shall be immediately transmitted to the owner.
7. The software required to provide the initial operation routines shall not consume more than 70% of the programmable capability of the controller.
8. The software shall be provided in these five categories:

    a. System executive software
    b. Software for user control over system configuration at the main controller location, and by Maintenance Personnel in the field
    c. Facility monitoring functions
    d. Direct digital control
    e. Application software

9. Each category of software shall consist of interactive software modules. Each module shall have an associated priority level and shall execute as determined by the program controller as defined in the real time operating system.
10. The building operator shall be able to communicate and direct all control functions through the use of a 2-button "mouse" operator interface to monitor and control all functions and sequences within the system.

11. The main controller shall allow receipt of alarms and messages while in a functional mode other than energy management, i.e. incoming alarms shall be displayed while the operator is in a word processing, spreadsheet or other operating mode. The system must automatically switch from a non- energy management mode, respond to an alarm, and return to the exact position left in the previous functional mode.
12. The main controller must be able to generate standard ASCII file formats to allow use with third-party software (MicroSoft Excel) to generate and store owner-designed reports.
13. Provide programming tools to allow operators to change or generate new sequences of operations, including graphics templates and generate database, trending and other standard operations.

B. Systems Software:

1. The main controller shall display graphically, in up to 64 different colors, the following system information:

   a. Floor plan maps shall show heating and cooling zones throughout the buildings in a range of colors which provide a visual display of temperature relative to their respective setpoints. The colors shall be updated dynamically as zones' comfort condition change. Locations of space sensors shall also be shown for each zone. Setpoint adjustment and color band displays shall be provided as specified.
   b. Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. It shall also provide a current status of all I/O points being controlled and applicable to each piece of equipment including analog readouts in appropriate engineering units at appropriate locations on the graphic representation.
   c. The following information shall be selected from a "pop- up" menu available on various graphics:

      Quit
      Alarms
      Messages
      Schedules
      Schedule Graphs
      Schedule Groups
      Trends
      Setpoints
      Module Status
      Programming Parameters
      Utilities

   d. Programming, scheduling and set-point changes shall be accessible for modification on each menu for the associated equipment. Operator shall be able to automatically download changes from the main controller to the appropriate program for the equipment being controlled. Operator shall be able to upload information from the field modules to the main controller.

2. Input Format: Allowable operators, as defined under user access, shall be able to control system functions by their inputs at an appropriate user terminal. The primary operator interface shall be via two button mouse.
3. Verification of Operator Input: The system shall acknowledge all inputs as functions or commands to be performed. The system's handling of operator inputs, such as requests to start a motor, output a log, change a time program, acknowledge an alarm, or do any of the other commands described in this specification, shall be in a similar format.
4. Operator Commands: All operator commands shall be in graphics data base and

menu driven. After the operator selects the desired object item or menu, the system shall display either the status of selected object item or the allowable options available. Upon entry of a command to the point or points desired as described above, the system shall, before performing any command requested and any entered data. System shall include error monitoring software for user's input error.

5. Output Format: The system shall operate on a System Format basis, regardless of the manner or hardware configuration in which the data is acquired. A "system" shall consist of a logical grouping of data points, related to a piece of mechanical equipment, an energy distribution system, or an architectural area. For example, in some cases, it may be desired to display, as a single system, a space temperature with its associated air handling unit, and in other cases to display all space temperatures on a floor or in a building. The DDC shall allow such determinations to be made without regard to the physical hardware locations of a point or group of points. Likewise, the system shall accommodate future changes of system grouping and operations without field hardware changes.

    a. All displays and logs shall contain a header line indicating date, day-of-week, and time.
    b. All output displays or logs of a point or group of points shall contain, as a minimum, the following information:

        (1) Graphic presentation of the System
        (2) User name of point
        (3) Point descriptor
        (4) Current value/status
        (5) Associated engineering units
        (6) Alarm description

    c. User names, point descriptors, and engineering units shall be operator definable on a per point basis.

6. Setpoints:

    a. The system shall utilize a contiguous band of colors each corresponding to actual zone temperatures relative to the desired heating and cooling setpoints. The ideal temperature shall be shown as a green color band. This color band corresponds to the dead band between the onset of mechanical heating or cooling. Temperatures slightly warmer than ideal shall be shown in yellow, and even warmer temperature band shall be shown in orange.
    b. Temperatures slightly cooler than ideal shall be light blue, and even cooler temperatures shall be shown as dark blue. All alarm colors shall be in red.
    c. The system shall be capable of utilizing the mouse operator interface device to change individual zone temperature setpoints. The change shall be accomplished by pointing to a graphic temperature bar and by depressing a button, moving the mouse cursor to an increased or decreased temperature set-point within that zone. The system shall also be capable of utilizing the mouse interface device or a conventional keyboard to change a numeric temperature set-point value instead of utilizing the graphic temperature bar. The floor plan graphic shall then be able to change colors on a zone by zone basis to reflect the actual temperature in each zone relative to the changed desired heating or cooling set-point.

d. The system shall be capable of globally changing all setpoints. The global change capability shall be accessed via a "pop up menu" called by depressing a button on the mouse.

7. Graphic Structure: The intent of the graphics is to ensure the operator is always aware of his position within the system as well as how to logically progress through the graphical hierarchy to select any desired graphic or other source of information. The GUI will be served as a web page and access from any computer without any special software or hardware keys. The building network controller will hold the graphics for standalone operation. A computer on site will not be acceptable to serve the graphics. The server computer will have the ability to access the system for engineering from the owner, alarming archives and alarms, remote monitoring of the health of the communications to the field devices and to archive the trend collection data from the building controllers. The web pages will follow a minimum standard as described below:

a. Graphical layout shall be as follows:

1) Main greeting page will have links for all building monitored for quick access.
2) Once a building is selected a picture of the building will be displayed along with a menu of all systems controlled from this section. There will also be links for the floor plans.
3) Once the floor plan has been chosen, the selected graphic page will display the architectural floor plan. This plan will have temperature readings and Setpoints of all VAV’s within this floor. There will also be links or button depicting the location and equipment number that is serving that area. This link will hyperlink into the graphic of the AHU. The temperature and setpoint reading will hyperlink to the selected VAV graphics for further review. If the floor has too many VAV data readings to display for an easy reading the floor plan may be broken into sections so that the view is easily readable.

b. Graphical VAV – The VAV box will be a graphical representation of a VAV box. The data shown on the box will be as follows:

1) Box Flow
2) Box Flow Trend hyperlink
3) Box Flow Setpoint
4) Box Flow Trend hyperlink
5) Box Flow Min Setpoint
6) Box Flow Max Setpoint
7) Box Flow Reheat Min Setpoint (if applicable)
8) Reheat Stage Commands (if applicable)
9) Supply Air Temperature (with reheat)
10) Room Setpoint
11) Room Setpoint Trend hyperlink
12) Room Temperature
13) Room Temperature Trend hyperlink
14) Room Humidity (If applicable)
15) Room Humidity Trend hyperlink
16) Room Humidity Setpoint (if applicable)
17) Room Humidity Setpoint Trend hyperlink
18) All points above to show a different status color if overridden

c. Graphical AHU – The AHU will be a graphical representation of the physical air handling unit specified. The data will be located on the AHU as physically located on the unit. The data on the AHU will be as follows:

1) Schedule for Unit hyperlink – link to the scheduling editor
2) Schedule for Ventilation hyperlink – link to the scheduling editor.
3) Occupied/Unoccupied status for each schedule
4) Fan command
5) Fan status
6) Fan speed
7) Fan VFD alarm
8) Temperature sensors as specified in the control sequence of operation and trending points
9) All setpoints as specified in the sequence of operation

a) Example – VAV AHU will have a supply air temperature and setpoint

10) Supply air static and trend hyperlink
11) Supply air static Setpoint and trend hyperlink
12) Return air damper position
13) Outside air damper position
14) Outside air flow and trend hyperlink
15) Outside air flow setpoint and trend hyperlink
16) Outside air heater command
17) Outside air heater setpoint
18) Any misc points needed from a sequence of operation
19) All points above to show a different status color if overridden

d. Graphical Chiller plant – The plant will be a graphical representation of the physical chiller plant as specified and installed. The data will be located on the graphical screen as physically installed in the plant.

1) All Chiller interface data
2) Enable/Disable of Chillers and isolation valves
3) Primary pump command and status
4) Secondary Pump command, status, speed, and general alarm from the VFD.
5) Flow meters
6) Temperature sensors

a) Misc. Points and graphical screens

e. Graphical representation of text on these screens – The text blocks will have an opposing color for easier reading

f. Graphical representation of the trends – each point to be trended will have an icon next to the point being trended. This icon will hyperlink to the trending chart builder for the individual trend screen. A trend icon on the main building screen will be a trend chart builder. This trend builder will allow to select multiple trends from a list, pick whether recent trending data or archived (in the server), date range, etc. Then after selection the trend chart builder will compile the data and build the trend for viewing or exporting to a spread sheet. This all happens with a standard web browser.

g. A text block for an overridable point shall be highlighted when a mouse is scrolled over an object. When the text block and or point is overridden

the graphical point will turn to a different color. This allows for easy viewing of which points are overridden on a graphic screen.

8. User Access Restriction. Operator sign-on shall require an assignable password. Passwords shall have four (4) levels of system access or user defined:

    a. Level 1 - Trainee: The level shall allow readout of data only. The system shall display all operation data base.
    b. Level 2 - Maintenance: This level shall allow performance of Level 1 functions plus the changing of all setpoints.
    c. Level 3 - System Programmer: This level shall allow performance of Level 3 functions plus the modifying the system configuration.
    d. Level 4 - System Manager: This level shall allow performance of Level 4 functions plus the changing of passwords.

9. Power Failure/Automatic Restart:

    a. Power failures shall cause the system to go into an orderly shutdown with no loss of program memory.
    b. Upon resumption of power, the system shall automatically restart and printout the time and date of the power failure and restoration at the main controller.
    c. The restart program shall automatically restart affected field equipment. The operator shall be able to define an automatic power up time delay for each piece of equipment under control.

C. User Control Over System Configuration:

1. Database Creation and Modification. All changes shall be done utilizing standard procedures and be capable of being done while the system is on-line and operational. The system shall allow changes to be made through the portable operator terminal and form the main controller. To aid the user, instructive prompting software shall be provided.
2. The system shall permit the operator, with proper password, to perform as a minimum the following:

    a. Add and delete points
    b. Modify point parameters
    c. Create and modify control sequences
    d. Reconfigure application programs
    e. Add and/or modify graphics

3. All data points within the database shall be completely accessible as independent or dependent variables for custom programming, calculation, interlocking, or manipulation.
4. Graphics Software:

    a. The graphics software shall permit the easy construction of infinitely variable shapes and sizes through the use of the mouse pointing device.
    b. The graphics shall include a digital picture of the school with school name on the front page of the graphics.
    c. A selection of 64 colors and various fill textures, line types and text styles shall all be accessible through the use of the mouse interface. The software shall resemble many of the computer aided design programs currently available and allow graphics to be easily moved, edited, added or deleted.

d. Graphics software shall be fully implemented and operational to accomplish the following:

(1) Create a new graphic picture
(2) Modify a portion of a graphic picture
(3) Delete a graphic picture, or any portion thereof
(4) Call up a graphic picture
(5) Cancel the display of a graphic picture
(6) Assign conditions which automatically initiate the display
(7) Overlay alpha-numeric and graphics
(8) Save the graphic picture
(9) Display latest process data fully integrated with the graphic display

D. Facility Management Functions (Contractor to coordinate with ICTS & Energy Management for access):

1. Trend Logging:

a. The system shall be able to trend and display either numerically or graphically any analog or digital points in the system.
b. System shall be able to simultaneously graphically display any two trended points within a module function block or any point in the module versus the outside air temperature, enthalpy or relative humidity.
c. Each module shall be capable of automatically uploading on a daily basis all accumulated trend data to the main controller for permanent storage on hard disk. All trended data shall be transferred to the central server and shall be available for use by Energy Management staff.

2. Run Time:

a. The system shall provide run time information for all digital output and input points on command from the operator. Maximum run time limits shall be operator definable and shall be capable of automatically issuing a visual when the run time maximum is exceeded. The operator shall be able to reset the run time accumulator.
b. Run time hours and start time date shall be retained in non-volatile module memory.
c. Each module shall be capable of automatically uploading all accumulated data to the main controller for permanent storage on hard disk.

3. Alarm Conditions and Maintenance Messages:

a. The main controller shall allow receipt of alarms and messages while in a functional mode other than energy management. i.e., Incoming alarms shall be displayed and generate an audible alarm while the operator is utilizing another mode such as word processing and allow the operator to automatically return to word processing after the alarm is received.
b. The system shall distinguish between alarms and messages with alarms having a higher priority.
c. The system shall be capable of calling up to three different remote locations to deliver an alarm or message through E-Mail, E-Page or alphanumeric page or other appropriate method. The operator shall determine conditions for alarms or messages; coordinate with the Owner to determine conditions but, typically any condition, or set of conditions,

that would cause the plant to shutdown or have the potential to damage equipment or injure personnel would merit such direct reporting.

d. The system shall be capable of printing maintenance messages when run time accumulation maximum limits are exceeded.

e. The text for operator alarm and messages shall be operator definable. The system shall be capable of storing at least 100 messages each of any length. Generic messages used for multiple points throughout the system shall only count as one message. In the event the main controller is powered down, the alarms shall be stored in the modules until the main controller is restored.

f. The main controller shall be capable of transferring all alarms to hard disk for storage.

4. Reports and Archiving:

a. The field modules shall be capable of automatically uploading all current and accumulated data. This shall be delivered to the main controller for printing and/or permanent storage on hard disk. The system shall further be capable of transferring hard disk information onto a floppy disk or magnetic tape for remote site storage.

b. The system shall be capable of reporting and archiving the following information as a minimum:

(1) Outside air temperature history and degree day history
(2) Electric demand and usage history
(3) All trended points
(4) All alarms and messages
(5) Equipment runtime information

c. The system shall also provide the following additional reports for which archiving is not applicable:

(1) All points summary
(2) Building operating schedules
(3) Printout of any graphic screen

d. The system shall be capable of providing all points summaries on a hierarchical basis. e.g., only the points associated with a particular graphic shall be selectable and printed. For example, if the operator is viewing an air handling unit (AHU), he may request an all points summary at this level and receive only the points associated with the AHU. If the building is being viewed and an all points summary selected, all building points will be listed. Similarly, the system shall print building operating schedules pertinent to the graphic level being viewed. e.g., If a zone or tenant zone group is being viewed on the graphic display, then the system shall be capable of printing the building operating schedules for the zone or tenant zone group. If the entire building graphic is being viewed, the system shall be capable of printing schedules at the building level. All systems reports shall be capable to being viewed at the operator’s terminal and printed at the operator's discretion.

E. Direct Digital Control Software:

1. The system shall continuously perform DDC functions at the local DDC controller in a stand-alone mode. The operator shall be able to design and modify the control loops to meet the requirements of the system being operated. The

operators shall use system provided displays for tuning of PID loops. These displays shall include the past three input variable values, the setpoint for the loop as well as the sample interval and the results of the proportional, integral and derivative effects of the final output.

2. Each Controller shall perform the following functions:
   a. Identify and report alarm conditions
   b. Execute DDC algorithms
   c. Execute all application programs indicated on the I/O Summary table
   d. Trend and store data
3. In the event of a Controller failure, all points under its control shall be commanded to the failure mode.
4. All DDC software shall reside in the respective DDC Controller.
5. Software and graphics should work across browsers and equipment (PCs, notepad computers, tablets, etc.) and be accessible from any networked computer. Variables should be expressed I basic units, such as GPM, CFM etc., conversion should not be required. Note that Java based platforms for graphics and other interfaces cause on-going problems; include Java updates continuously or avoid such applications.

F. Application Software: Application software shall be as required to produce the sequence of operation specified in Section 23 09 93 – Sequence of Operations for HVAC Controls.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. All system components and appurtenances shall be installed in accordance with the manufacturer's instructions and requirements. All necessary interconnections, services and adjustments required for a complete and operable system shall be provided by this contractor.

B. The contractor shall review all contract drawings and specifications, including addenda and referenced material and shall visit the job site, if applicable in order to become informed prior to bidding as to existing conditions and limitations of the project. The contractor shall bring exceptions and inconsistencies in drawings, specifications, addenda, referenced material, other contract documents and site conditions to the attention of the engineer.

C. The location of material, equipment and devices shown on the drawings are approximate and are subject to such revisions as may be necessary or desirable at the time that the work is being installed. The contractor shall install the work in relation to existing conditions. Should project conditions require rearrangement, or if equipment or accessories can be installed to better advantage in a different manner, prepare and submit five copies of shop drawings indicating the proposed rearrangement for the Engineer's review.

D. Chilled Water: Furnish a test well for installation under Section 23 05 19 – Meters, Gages and Accessories for HVAC Piping, adjacent to each temperature sensor where a fixed thermometer is not provided.

E. Control Wiring:

1. All wiring incidental to the building control system, including electrical interlocks shall be included in this section and provided as part of the building control system.
2. All control wiring shall be run in conduit where required by code or where the possibility of harm or permanent damage exists; above lay in ceilings is permitted to be free wire. In addition, all wiring installed below 8 feet or below suspended ceilings shall be installed in conduit.

3. Any wiring not installed in conduit shall be multi-conductor cable, with individual wires color codes for ease of installation and troubleshooting. All wiring installed above a plenum ceiling shall be Teflon coated and rated for plenum service.
4. All wiring shall be concealed wherever possible, and installed in a neat and workmanlike manner. All wiring and conduit shall be run parallel or perpendicular to the building structure. All cables shall be supported at frequent intervals and attached to supports by the use of nylon tie-wraps.
5. Control wiring shall conform to the requirements of Section 23 05 18 – Control Wiring.

F. Terminal Controls: Unless provided by the terminal manufacturer, Direct Digital Controllers controlling VAV boxes, damper operators and velocity transmitters shall be shipped to the VAV box manufacturer for factory installation. Provide the box manufacturer with complete wiring and piping diagrams and detailed installation instructions. Box manufacturer shall furnish and install 24 volt transformer.

G. System Start-up and Check-out:

1. The manufacturer shall provide a control technician for the start-up, check-out of all input and outputs, implement and check the software function and submit report on check-out of each system.
2. Demonstrate to the Owner that all functions are operating as per final approved sequences.
3. The manufacturer shall provide a control technician for the training of the Owner's operators as detailed in Division 01 Requirements.

H. System Acceptance & Trend Log Submittal:

1. After completion of the installation, check-out and control loop tuning, and trend logs shall be submitted, as listed below, to demonstrate the satisfactory performance of the system and to serve as a data base for the owner's future use.
2. The trend logs shall be organized in spread sheet format and presented in both tabular and graphical form. A disc or tape copy of each final accepted trend log set shall also be provided. Trend logs shall be as follows:
3. Control Stability Trend Logs:

    a. Each digital or analog output to valves, dampers, adjustable frequency drives and other control devices shall be included.
    b. Scan time shall be at five second intervals for duration of ten minutes.
    c. Start of the sets shall be immediately after change from one mode to another, i.e., unoccupied to occupied, no economizer to economizer, off to on, etc. Only one log will be required for each output as long as it addresses all controlled elements.
    d. Where control of a piece of equipment is by factory furnished packaged controls, then the controlled temperature which is monitored shall be included. For instance, where a chiller is controlled by its own control system and control is from leaving chilled water temperature, then leaving chilled water temperature shall be included in the log set.

4. System Operation Trend Logs:

    a. Each measured value (temperature, pressure, amps, etc.), equipment status (on-off, percent speed or position, etc.), each mode (unoccupied, cool-down, occupied, etc.), each setpoint and each alarm shall be included.
    b. Scan time shall be at operation adjustable intervals with duration of 24 hours.
    c. Sets shall be included for cooling only, cooling plus economizer and heating only. Where start up occurs at a defined season and both heating and cooling cannot be logged, then the system will be accepted subject to a final demonstration of the other season, when weather permits.

5. Load Profile Trend Log Sets:

    a. The total campus load in tons shall be calculated using flow and temperature difference between the supply and return water.
    b. Chiller plant load shall be calculated using chiller flow and temperature difference between the supply and return water.
    c. Heat rejection load on water cooled equipment shall be calculated based on condenser water flow and temperature difference between supply and return water.
    d. Compressor power input (KWH) shall be calculated based on measured KW or volts and amps and a look-up table provided by the compressor supplier. This shall be logged and converted to tons (KW x 3414 divided by 12,000) and compared to the compressor tons obtained by subtracting chiller tons from condenser tons.
    e. Tonnage shall be calculated by averaging six instantaneous readings per hour taken at ten minute intervals. Tonnage for each of the 24 hours shall be listed.

6. Energy Use Trend Log Sets:

    a. Energy use (KWH) of each chiller compressor shall be calculated using KWH or measured volts, amps and a look-up table provided by the manufacturer.
    b. Energy use of each dedicated primary chilled water pump, condenser water pump and cooling tower fan shall be calculated using measured KWH or volts and amps prorated to motor nameplate data to convert to KW. Chiller auxiliary power use (KWH) shall be added to the chiller power use to get each individual chiller system power use.
    c. Energy use of the secondary chilled water distribution pumps shall be obtained in a similar manner and added to the chiller system energy use to get central plant total energy use. This shall be compared to the measured central plant KWH where available.
    d. Energy use of each fan shall be calculated using measured amps and a look-up table provided by the motor manufacturer to convert to KW.
    e. Energy use of constant flow exhaust fans, small pumps, etc. shall be estimated based on input data of KW taken from the test and balance data and added based on fan on or off status.
    f. The sum of all HVAC power use shall be totaled and listed.
    g. KWH shall be calculated by averaging six instantaneous KW readings per hour taken at the same ten-minute intervals as the load measurements. Each chiller, central plant and total building energy use shall be converted to KW/ton and listed.

h. Energy consumption of the entire building shall be taken from the power company meters and listed.
i. Outdoor air wet-bulb shall be listed.
j. Data shall be presented for each of the 24 hours each day.
k. Energy use shall be presented in bar graph form.
l. Fully coordinate with Division 26 to ensure the meter will allow connections to the BCS system for downloading and trending of the power consumption.

7. Custom Trend Log Sets:

a. The operator shall have the ability to customize all trend logs by adjusting both sampling time and duration.
b. After the initial graph data is accepted, the print-out shall be changed from a fixed interval to a change of value.

8. Trend Log Design: As a part of the initial submittal process, the proposed trend log format shall be submitted for approval, but shall include the follow as a minimum:

a. Hardware and software shall sub-meter and/or monitor and trend the following (trending shall be in 30 minute intervals unless directed otherwise by the project manager):
b. Chiller, cooling tower and associated pump operational status, power consumption and demand rate, inlet and outlet eater temperatures and water flow rates.
c. Air-handling unit fan status, speed, power consumption, valve position, water flow rate, inlet and outlet water temperatures and air temperatures.
d. Exhaust fans interlocked with air-handling units: operational status.
e. Sub-metering: BCS shall accept input from sub-meters for water, natural gas, and electricity to kitchens and cafeterias and for the points listed above.
f. Generator: BCS should accept input from emergency generator(s).

3.2 EQUIPMENT ADDITIONAL REQUIREMENTS

A. Smoke Detectors:

1. Smoke detectors will be furnished and installed under Division 26. Power wiring, alarm circuit and supervisory circuit will be provided under Division 26. Control wiring to auxiliary contacts required to shut-down fans (hard wired) and alarm BCS shall be provided by this Section.
2. All detectors shall function properly, equipment shall shut-down and dampers must be tested for operation prior to building occupancy with design air flow to ensure operation under normal conditions. Provide a letter to the Owners Representative certifying that these tests have been conducted.
3. When an engineered smoke control system is specified, the smoke detectors shall function as specified.

B. Air Flow Measuring Stations:

1. Install air flow measuring stations on the inlet bells of the fan as specified. 120V AC power wiring and control wiring will be provided under this section.
2. For airflow measuring stations that cannot be mounted on the inlet bells of the fan, furnish air flow measuring stations for installation under Section 23 33 00 - Air Duct Accessories wiring will be provided under this section.

3. Coordinate location, duct size and confirm that there is proper space for access before releasing for fabrication. Coordinate installation requirements with sheet metal sub-contractor as specified in Section 23 33 00 - Air Duct Accessories.

C. Dampers:

1. Unless specifically stated otherwise, the outside air, return air and relief air dampers for all air handling units shall be provided under this section of the specifications. Where damper sizes are not shown on drawings, size outdoor air and relief air dampers at 1500 ft/min. and return air dampers at 2120 ft/min. face velocity. Discharge dampers shall be furnished on systems over 5000 CFM. Where so indicated, provide separate minimum and maximum O.A. damper.
2. Return air, relief air and discharge dampers to be smoke rated on systems over 15,000 CFM and arranged to close in response to smoke detector or function as specified in an engineered smoke control system.
3. Turn dampers over to sheet metal contractor for installation as specified in Section 23 33 00 - Air Duct Accessories.

D. Line Voltage Thermostats: (Used only for exhaust fans only, not for classrooms HVAC Systems). Provide and wire including necessary outlet box, conduit box and all interconnecting wiring.

E. Room Temperature Sensors:

1. General:

a. Provide a room temperature sensor in each location shown on the drawings.
b. Each room temperature sensor shall be wired to a local control device that shall maintain the established setpoints within the space in response to time, mode and temperature inputs.
c. Each sensor shall have a digital display and an override button, except for the corridors will not have an override button.

2. Room Temperature Sensor Mounting:

a. In classrooms and offices, each room sensor shall be installed immediately inside door, next to the light switch with its center approximately 4'-0" above the floor. Each room sensor mounted on an exterior wall of the building with an insulating block of wood or other approved material.
b. In public spaces and other unsupervised areas, locate temperature sensors with its center approximately 4'-0" above the floor and a wire cage around the sensor (Lexan covers are not acceptable).

G. Carbon Dioxide Monitor - Controller: Install in the space as shown on the drawings.

3.3 SOFTWARE ENHANCEMENTS

A. Include an allowance for revisions to the software as required to provide a complete and workable system consistent with the intent of the specification. All control performance criteria are specified in the Sequence of Operations section of the specification.

B. After the system has operated properly for 90 days following start-up of the final component of the heating and air conditioning systems, an as-built copy of the system shall be transmitted to the owner for permanent record purposes. An allowance shall also

be included for any software upgrading or enhancements to improve the system operation or as required for proper operation of the system during the FIVE years of operation shall be the responsibility of the BCS contractor. Any changes to the software shall be immediately transmitted to the owner.

3.4 CALIBRATION AND TESTING

A. The Building Control Contractor shall calibrate all building controlled system equipment and verify operation before this system is placed on-line. All testing, calibrating, and adjusting shall be completed by the contractor prior to the start of the acceptance test; including all DDC control loops, interlocks, sequences, energy management programs, and alarms shall be tested and proper operation verified.

B. The Product Integrated Controls shall be factory installed, configured and tested for stand-alone operation. Specific configuration, such as setpoints and time schedules, shall be completed before the HVAC equipment on which it is installed and is placed in operation. All testing, calibrating and adjusting of individual HVAC equipment PIC controls shall be done as a part of that individual unit start-up and acceptance. Only the PIC's network communications function shall be included with the automation (BCS) acceptance test.

3.5 ACCEPTANCE TEST

A. After start-up and calibration, the building controls sub-contractor shall submit to the engineer trend logs of all points on each system demonstrating stable and proper operation. The demonstration shall cover the following conditions:
   1. Cooling Only (O.A. Temperature > 70°F).
   2. Cooling and Heating (O.A. Temperature 55°F to 70°F).
   3. Heating Only (O.A. Temperature < 40°F).

B. After submission of the logs for any one of the periods, the engineer will review them for acceptability, and if acceptable, schedule a final walk-thru of the system for final acceptance and start of hardware warranty.

C. During the hardware warranty period, the controls sub-contractor shall submit trend data covering the other two periods. Any adjustments or modifications to get acceptable results in each period shall be considered to be part of the warranty obligation.

3.6 SEQUENCE OF OPERATION

A. Refer to Section 23 09 93 - Sequence of Operations for HVAC Controls, drawings and schedules for actual system and equipment details.

END OF SECTION 23 09 23

SECTION 23 09 93 – SEQUENCE OF OPERATION FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Provide all labor, material, documentation and services required for the implementation of the Sequences of Operation detailed herein.

1.3 RELATED WORK

A. Section 23 09 23 - Instrumentation and Control Devices for HVAC.

1.4 APPLICABLE PROVISION

A. Where modulation of a valve or damper is referred to then it shall mean the direct digital control of the valve or damper based on a control algorithm resident in the BCS software at the remote field panel. Unless noted otherwise the control algorithm shall be PID control. Optimum loop response shall be ensured by the use of a built in automatic loop tuner.

B. An Operator having the required level of password access shall be able to modify the Operator changeable or definable parameter(s) on-line from an I/O device such that the monitoring and control functions of the BCS shall not be affected during the period of the change. The mechanism by which the change is made shall be adequately described in the Operator's manuals. Where setpoints for control parameters such as setpoint or changeover temperatures, humidities times are referred to in this Section they shall be Operator changeable on-line.

C. Where the sequences refer to the start/stop of a system this shall be initiated either by an Operator manually entered command or automatically by a software routine such as "Optimum Stop/Start", "Power Demand Control", "Programmed Stop/Start", etc. or via an interlock in the sequences of operation to other equipment or event(s).

D. When the motor controller is equipped with a HOA the motors shall only be controlled by the BCS when the HOA switch is in the auto position.

E. Firestats, freezestats, smoke and fire detectors and interlocked dampers shall be wired to shutdown motors when the HOA switch is in both the hand and auto positions. It shall not be possible for the BCS to override these or any other safety devices or any fire alarm system control functions.

F. Provide additional I/O points, whether or not such points are indicated in the Point Definition Sheets, if they are required in order to attain the requirements of the Contract Documents.

G. Where fans and dampers are to be interlocked, provide hardwire interlocks between the motor terminal strip and damper such that the damper shall be driven open when the motor is required to start. Motor start-up shall not occur until the damper end switch indicates the damper is in the full open position.

H. Where fans and dampers are hardwire interlocked, the interlocks shall apply in both the "hand" and "auto" positions of the HOA switch at the motor controller.

I. Where electric heat coil control calls for the electric heating coil to be staged/cycled on and off to maintain the required temperature set point, the control algorithm shall incorporate a deadband, changeable by the Operator, which shall prevent the too frequent on/off cycling of the heating coil.

J. Where electric heating coils are controlled by the BCS, the BCS shall not override any safety interlocks.

K. Where there are fans not identified within the sequence of operation, point definition sheets or schematic drawings that provide supply and/or exhaust air that are not controlled via a thermostat, they shall be hardwire interlocked to the controlling device. The supply fans shall be hardwire interlocked with their associated exhaust fan (if applicable) to operate simultaneously. The dampers shall be hardwire interlocked with the fans via end switches such that the fans cannot operate when the damper is not fully open. The damper status shall not be monitored by the BCS. If the supply or exhaust fan serves multiple dampers, the end switches of the dampers shall be wired in parallel as a group then wired in series with the fan's associated damper end switch to prevent the fan from operating unless both the fan's damper is open and at least one of the system dampers are open.

L. The point list is provided for convenience and is not intended to be all inclusive. All points required to provide the Sequence of Operation shall be included as if listed.

M. All wiring required to provide the Sequence of Operation shall be included.

1.5 ABBREVIATIONS

AFD	Adjustable Frequency Drive
AUX	Starter Auxiliary Contact
AI	Analog Input
AO	Analog Output
CFM	Air Flow in CFM from Air Monitor
CSR	Current Sensing Relay
D	Damper Operation
DI	Digital Input
DO	Digital Output
DP	Differential Pressure
ES	End Switch
Fa	Failure Alarm
FC	Filter Change Alarm
FR	Freezestat
FS	Flow Switch
H	Humidity Sensor
Ha	High Static Pressure Alarm
IAQ	Indoor Air Quality
IGV	Inlet Guide Vanes
La	Low Static Pressure Alarm
Ma	Maintenance Alarm
OVM	Override Message
Pd	Discharge Static Pressure
Pdd	Downduct Static Pressure
Pds	Discharge Static Pressure Safety
Ps	Suction Static Pressure
Pss	Suction Static Pressure Safety
R	Relay
Sa	Safety Alarm/Shut-down

SD	Smoke Detector
SP	Static Pressure Sensor
SR	Damper Smoke Rated
SS	Start-Stop
T	Temperature Sensor
Ta	Temperature Alarm
V	Valve Operator
VP	Virtual Point
X	Hardwired Item

PART 2 – PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 SEQUENCE OF OPERATION – EQUIPMENT

A. Refer to the drawings for sequences and points required.

B. Provide 40 hours of an onsite technician to support the performance functional testing by the commissioning agent.

END OF SECTION 23 09 93

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SECTION 23 21 13 – HYDRONIC 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 WORK INCLUDED

A. Chilled Water (CHS/CHR) Piping.

B. Equipment Drain (D) Piping.

C. A/C Unit Condensate Drain (CD) Piping.

1.3 DEFINITIONS

A. The pipe sizes given in this document are nominal.

1.4 QUALITY ASSURANCE

A. All material provided under this section shall be standard catalogued products of recognized manufacturers regularly engaged in the production of such products, and shall be of the manufacturer's most recent design that is in regular production.

B. Each item provided under this section shall meet the requirements for that item as installed and used, in accordance with the following standards:

1. Metallic Piping Systems employing mechanical joints - ASME/ANSI B-31.9
2. All other metallic piping - ASME/ANSI B31.1.

C. Each piping system shall be in accordance with the system design pressures shown in paragraph 2.1 - Materials, this specification section.

D. All materials provided under this section shall be new, except where the specifications and/or drawings permit the reuse of certain existing materials.

E. Source Limitations: Unless specifically noted otherwise, provide products of the same manufacturer for each type of unit specified.

F. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.6 SUBMITTALS

A. All submittals shall be made in accordance with Division 01 requirements.

B. Submit a list identifying the specific type of material that will be used for each piping system. Include pipe, pipe fittings, valves and joints. Include the basic designation of the publication applicable for each type of material and method.

C. If applicable, submit current welder qualifications for all welders proposed for this project. Welding certificates shall be for the company performing the welding at this project as directed in paragraph 3.2 - BRAZING AND SOLDERING.

D. If applicable, submit certified welding inspection reports as directed in paragraph 3.2 - BRAZING AND SOLDERING.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Chilled Water (CHS/CHR) Piping – Above Ground.
System Design Pressure: To 150 psig.

1. Piping, 1/4" thru 1-1/2": Contractor's option:

   a. Type ‘L’ or ‘K’ Hard-drawn Copper Tubing: ASTM B88.
   b. Schedule 40 carbon steel, seamless; ASTM A-106, Grade B, Type S.
   c. Schedule 10S stainless steel, ASTM A-312, Type 304/304L.

2. Piping, 2" and larger: Schedule 40 carbon steel, seamless or electric resistance welded; ASTM A-53, Grade B, Type S or ERW.
3. Pipe Fittings: 1/4" thru 1-1/2": Contractor's option:

   a. Wrought Copper, ANSI B16.22.
   b. 150lb. malleable iron threaded; ASTM A-197.
   c. Mechanically formed tee fitting, as created by T-Drill, is an acceptable method of installation.
   d. Stainless steel fittings shall be precision, cold drawn, stainless steel with elastomer O-ring seals, suitable for working pressure to 500-psig (3450-kPa). Victaulic Vic-Press.

4. Pipe fittings 2" and larger: Schedule to match mating pipe, carbon steel, butt weld type; ASTM A-234. Weld-o-lets and thread-o-lets will be limited to 2 pipe sizes smaller than the pipe to which they are connected to.
5. Brazing: Contractors Option:

   a. 15% silver, 5% phosphorus, balance copper, 1190°F melting point. AWS 5.8 number BCuP-5. J.W. Harris Stay-Silv® 15 or approved substitution.
   b. NOTE: 95% soft solder is not acceptable.

6. Unions: 1/4" thru 1-1/2": Contractor's option:

   a. Wrought Copper, Pressure Class 150, w/solder ends.
   b. Malleable Iron, Pressure Class 150, w/ threaded ends, ANSI B 13.39.

   Note: Dielectric unions shall be used to connect copper to steel pipe, and shall have metal connections on each end threaded to match the adjacent piping. Metal components shall be separated by a nylon insulator to prevent current flow between dissimilar metals. Unions shall be suitable for the system operating pressures and temperatures.

7. Flanges: 150 lb. rated forged carbon steel, weld neck type, with raised face, bored to match the mating pipe I.D.; ASTM A-181, Grade 2, or ASTM A-105, Grade 2.
8. Bolting studs: ASTM A-193, Grade B7. Nuts shall be heavy duty hex type; ASTM A-194, Grade 2H.
9. Gaskets: Full faced style, 1/8"thick. Gasket material shall be Nitrile (NBR) sheet, ASTM F104, Line Call Out F712100A9B4E22K5M6; Based on Garlock Blue-

Gard® Style 3000 or acceptable equivalent.

10. Direct buried pipe shall be coated with a extrusion-applied, fusion bonded epoxy coating jacket, 0.040” minimum thickness. Equal to 3M-SkotchKote™.
11. Mechanical joint systems are acceptable for above ground applications ONLY. All below ground applications shall be fully welded.

B. Equipment Drain (D) Piping.
System Design Pressure: 10 psig.

1. Piping, 1/4" thru 2”: Type L Hard-drawn Copper Tubing: ASTM B88.
2. Piping, 2-1/2" thru 8": Schedule 40 carbon steel, seamless or electric resistance welded, galvanized; ASTM A-53, Grade B, Type S or ERW.
3. Pipe Fittings, 1/4" thru 1": Wrought Copper, ANSI B16.22.
4. Pipe Fittings, 1-1/2" and larger: 125 lb. rated galvanized malleable iron, threaded type; ASTM A-197.
5. Solder: Lead-free, per code.
6. Unions: 1/4" thru 1": Wrought Copper, Pressure Class 150, w/solder ends.
7. Unions: 1" thru 2": Malleable Iron, Pressure Class 150, w/ threaded ends, ANSI B 16.39.

   Note: Dielectric unions shall be used to connect copper to steel pipe, and shall have metal connections on each end threaded to match the adjacent piping. Metal components shall be separated by a nylon insulator to prevent current flow between dissimilar metals. Unions shall be suitable for the system operating pressures and temperatures.

8. Flanges: 150 lb. forged carbon steel, threaded type, with raised face, bored to match the mating pipe I.D.; ANSI B16.3.
9. Bolting studs: ASTM A-193, Grade B7. Nuts shall be heavy duty hex type; ASTM A-194, Grade 2H.
10. Gaskets: Full faced style, 1/8" thick. Gasket material shall be Nitrile (NBR) sheet, ASTM F104, Line Call Out F712100A9B4E22K5M6; Based on Garlock Blue-Gard® Style 3300 or acceptable equivalent.
11. Mechanical joints may be used on 2-1/2" IPS and larger. See paragraph 2.2 "Mechanical Joint Systems", this section, for specifications.
12. Drains, Indoor, not in Return Air Plenums - PVC:

    a. Schedule 40 Polyvinyl Chloride (PVC), ASTM D1785.
    b. Schedule 40 PVC, socket-type, ASTM D2466. Joints shall be made with solvent cement, ASTM D2564.

C. A/C Unit Condensate Drain (D) Piping.
System Design Pressure: 10 psig.
(Where two materials are listed, either may be used.)

1. Drains in Return Air Plenums or other areas - Copper:

   a. Piping, 1/4" thru 4”: Type L Hard-drawn Copper Tubing: ASTM B88.
   b. Pipe Fittings, 1/4" thru 4":

      1) Wrought Copper, ANSI B16.22.
      2) Mechanically formed tee fitting, as created by T-Drill, is an acceptable method of installation.

   c. Solder: Lead-free, per code.
   d. Brazing for Mechanically formed tee fittings: Brazing: Contractors

Option:

(1) 5% silver, 6% phosphorus, balance copper, 1190°F melting point. AWS A5.8 number BCuP -3. J.W. Harris Stay-Silv® 5 or approved substitution.
(2) 15% silver, 5% phosphorus, balance copper, 1190°F melting point. AWS 5.8 number BCuP-5. J.W. Harris Stay-Silv® 15 or approved substitution.
(3) 6% silver, 6.1% phosphorus, balance copper, 1190°F melting point. QQ-B-654A number BCuP -5. J.W. Harris Dynaflow® 5 or approved substitution.

e. Unions: 1/4" thru 4": Wrought Copper, Pressure Class 150, w/solder ends.

Note: Dielectric unions shall be used to connect copper to steel pipe, and shall have metal connections on each end threaded to match the adjacent piping. Metal components shall be separated by a nylon insulator to prevent current flow between dissimilar metals. Unions shall be suitable for the system operating pressures and temperatures.

2.2 MECHANICAL JOINT SYSTEMS – FOR ABOVE GROUND PIPING ONLY

A. General:

1. All couplings, fittings, and gaskets shall be the products of a single USA manufacturer (no exceptions).
2. Valve ends shall be compatible with the couplings used on the connecting piping.
3. All exposed piping shall be cleaned, removing all rust, primed and painted black. At substantial completion all exposed piping shall be free of rust and in a “like new condition”.
4. Fittings:

a. Steel Piping: Fittings shall be manufactured of ductile iron per ASTM A536; wrought steel per ASTM A234; or factory-fabricated from carbon steel pipe conforming to ASTM A53.
b. Copper-Tubing: ASME B16.22 wrought copper or ASME B16.18 cast bronze, manufactured to copper-tube dimensions. (Flaring of tube or fitting ends to accommodate alternate sized couplings is not permitted.) Victaulic Copper-Connection.

B. Pipe Wall Thickness:

1. Pipe having cut (machined) shall have a nominal wall thickness of not less than the wall thickness specified for Schedule 40 pipe of the particular pipe size.

C. Couplings:

1. Mechanical joint couplings shall be of the external type, for use with cut end pipes, fittings, and valves.
2. Couplings shall be self-centering, and shall engage and lock-in-place the pipes, fittings, and gaskets.
3. All couplings shall be of the rigid style. Flexible couplings shall not be used without the written approval of the Engineer.
4. Couplings shall be Ductile Iron, ASTM A536; and shall be designed for not less

than 250 psig at 230 Deg. F.

5. The coupling assembly shall be held together by two or more track-head, oval-neck steel bolts, ASTM A449 and A183.
6. Manufactured in two segments.
7. Couplings shall comply with ASTM F1476 – Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
8. Steel Piping:

    a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, with Victaulic Style 107H/107N (Quick-Vic™), Installation ready rigid coupling for direct stab installation without field disassembly. Gasket shall be Grade “EHP” EPDM designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C).
    b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings, for each connector, shall be placed in close proximity to the vibration source. Victaulic Style 177 (Quick-Vic™), Installation ready flexible coupling.
    c. Victaulic AGS Mechanical Couplings, 14 inch (DN350) through 60 inch (DN1500): Couplings shall consist of two ASTM A-536 ductile iron housing segments with lead-in chamfer on housing key and a wide-width elastomer pressure responsive gasket. Victaulic Style W07 AGS Rigid and Style W77 AGS Flexible Coupling

9. Stainless Steel: Victaulic Style 89 and Style W89, AGS series two-segment rigid coupling.
10. Copper-Tubing: Victaulic Style 607H, Installation-Ready coupling with offsetting, angle-pattern, bolt pads.
11. Dielectric Waterway: Copper silicon casting conforming to UNS C87850 with threaded ends. UL classified in accordance with NSF-61 for potable water service, and shall meet the low-lead requirements of NSF-372. Basis of Design: Victaulic Series 647.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Furnish and install piping, fittings and appurtenances required to complete the piping systems shown on the drawings. Elbows shall be long radius type. Tees may not be field fabricated.
2. Run piping to true alignment, generally parallel or perpendicular to building walls, floors and ceilings, and with uniform grades and spacing, so as to present a neat and workmanlike appearance.
3. Care shall be paid to the exact locations of piping with respect to equipment, ducts, conduits, slabs, beams, lighting fixtures, columns, ceiling suspension systems, etc. to provide maximum access to mechanical and electrical equipment in the building. Close coordination and cooperation shall be exercised with other trades in locating the piping in the best interests of the Owner. The drawings and specifications covering other work to be done in the building shall be carefully studied and arrangements made to avoid conflict.
4. Not all necessary pipe offsets are indicated on the drawings because of the small scale. The various runs of piping to be installed shall be studied and adjustments

made in exact routings as may be required for proper installation.

5. Conflicts arising during the erection of piping shall be brought to the attention of the Owner's Representative and Engineer of Record. No improvising or field changes will be permitted without the approval of the Engineer of Record.
6. Use full lengths of pipe wherever possible. Short lengths of pipe with couplings will not be permitted. Cut to exact measurement and install without forcing or spring unless otherwise shown on the drawings or specified.
7. Avoid tool marks and unnecessary pipe threads. Burrs formed when cutting pipe shall be removed by reaming. Before installing any pipe, care shall be taken that the inside is thoroughly cleaned and free of cuttings and foreign matter. Measures shall be taken to preserve this cleanliness after erection.
8. Arrange pipe connections to valves and specialties so that there is clearance for easy removal of the valve or specialty from the line, and also for the removal of the valve bonnet and interior, and the specialty top and bottom and interior, except where otherwise approved by the Engineer of Record.
9. Erect piping in such a manner so as to obtain sufficient flexibility and to prevent excessive stresses in materials and excessive bending movements at joints or connections to equipment. Make allowances throughout for expansion and contraction of piping. Provide each riser and horizontal run of piping with expansion loops, expansion joints, or expansion compensators where indicated and required. Securely anchor and adequately guide pipe as required or where indicated to force expansion to the expansion device without bending, binding, or misalignment of pipe. Branch connections from mains to risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Where indicated, in lieu of expansion loops, expansion joints, or expansion compensators, horizontal runs of pipe shall be anchored at approximately midway of the run to force expansion, evenly divided, toward the mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining.
10. Installed piping shall not interfere with the operations or accessibility of doors or windows and shall not encroach on aisles, passageways and equipment, and shall not interfere with the servicing or maintenance of any equipment. Adjacent pipe lines shall be grouped in the same horizontal or vertical plane.
11. Where lines are purposely pitched for drainage, an accurate grade shall be maintained. No lines shall be supported in such a manner as to permit deflection, due to gravity, sufficient to pocket the lines when full of liquid. Grade mains as indicated by arrows on the drawings and in accordance with gradient as indicated in attached Piping Schedule.
12. Piping found to have water hammer or other objectionable vibrations which cannot be eliminated by proper grading or other natural means, shall be braced, trapped or hung with shock absorbing hangers and equipped with air chambers, mechanical shock absorbers, flexible pipe connections or otherwise silenced using approved means.
13. Use building steel wherever possible for supporting pipe hangers. Main structural steel shall not be drilled, cut or burned for hangers without the approval of the Structural Engineer of Record. Expansion bolts shall be used only upon the approval of the Structural Engineer of Record.
14. Install unions or flanges in piping connections to equipment, regulating valves, and wherever necessary to facilitate the dismantling of piping and/or removal of valves and other items requiring maintenance.
15. Avoid bushings. Reducing fittings shall be used wherever practical.
16. The drawings indicate the size of piping and connections, and if certain sizes are omitted or unclear, obtain additional information before proceeding.
17. The piping drawings have been worked out with a view to the most economical installation, taking into consideration accessibility and appearances, and the

Contractor must follow the drawings accurately and if it is found impractical to install the work in accordance with the drawings and specifications, the Contractor shall notify the Engineer of Record before making any changes and get their approval or revised drawings before proceeding with the work. Verify all measurements on the job before cutting pipes or having piping fabricated, and be responsible for the correct location of all pipe connections, also check sizes and standard of outlets on the equipment, including the dimensions and drilling of flanges, etc.

18. Copper tubing and galvanized steel shall not be mixed in any one run of piping.
19. Change in direction shall be made with fittings.
20. Threaded joints shall be made with tapered threads in accordance with ANSI B2.1, and made tight with an approved pipe thread joint compound or material, applied to the male threads only. Use compounds sparingly and apply with caution to ensure that compounds do not enter piping systems. When pipe joint is made up a maximum of 3 threads shall be visible.
21. Joints for plastic pipe shall be made in accordance with PPI Piping Manual.
22. Connections between ferrous and nonferrous metallic pipe shall be made with dielectric unions or flanges.
23. Connections between plastic and metallic pipe shall be made with transition fittings manufactured for the specific purpose.
24. Unions and flanges shall not be concealed in walls, partitions, or above inaccessible ceilings.

B. Hydronic HVAC Systems Additional Requirements:

1. Provide a 3/4 inch drain valve and a capped hose nipple at each low point in each system, and where indicated.
2. Provide, at each high point in each system, and where indicated, an automatic air vent with drain line routed to the local floor drain.
3. Mechanically formed tee shall be formed in a continuous operation consisting of drilling a pilot hole and drawing out the tube surface to form a tee having a height of not less than three times the thickness of the branch tube wall s as to comply with the American Welding Society lap joint weld. The device shall be fully adjustable as to insure proper tolerance and complete uniformity of the joint. The branch tube shall be notched conforming with the inner curve of the run tube and have two dimple/depth stops pressed into the branch tube (one ¼” atop the other). This is to insure penetration of the branch tube into the tee is of sufficient depth for brazing and that the branch tube does not obstruct the flow in the main line tube. Dimple/depth stops shall be in line with the run of the tube. The second dimple shall be ¼” above the first and shall serve as a visual point of inspection. All mechanical formed tee fittings shall be brazed in accordance with the Copper Development Associations Copper Tube Handbook using BCuP series filler metal. *NOTE: Soft soldered joints will not be permitted. Contractor assumes responsibility for joints being installed in accordance with code and manufacturers’ recommendations.*
4. On liquid systems, make branch connections to top of mains for up-feed arrangement, and to bottom of mains for down-feed arrangement, except where main and branch line are of equal size the branch connection may be made to the side of the main for both up-feed and down-feed applications.
5. Provide water seal in the condensate drain from each air handling or air conditioning unit. The depth of each seal shall be equal to the total static pressure rating of the unit to which the seal is connected. Water seals shall be constructed of two tees and an appropriate U bend with the open end of each tee plugged.
6. Slope piping 1 inch per 40 ft, in the direction of flow.

3.2 BRAZING AND SOLDERING

A. Operator and Procedure Qualifications: All brazing operators and procedures shall be qualified in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

B. Brazing: Silver braze joints in accordance with MSS-SP-73 "Silver Brazing Joints for Wrought and Cast Solder Joint Fittings".

C. Soldering: Joints in copper tubing shall be made with solder- type fittings. Outside surface of the tube where engaged in the fitting, and inside surface of the fitting in contact with the tube, shall be cleaned with an abrasive material before soldering. Self- cleaning compounds shall not be used. Care shall be taken to prevent annealing of tube and fittings when making connections. The solder joint shall be made with flux and wire form solder, except brazed joints. The flux shall be a mildly corrosive liquid or a petroleum based paste containing chlorides of zinc and ammonium. Solder shall be applied and drawn through the full fitting length. Excess solder shall be wiped from joint before solder hardens. All joints to be wiped clean after soldering. Joints in copper tube sizes 2-1/2 inches and larger shall be made with heat applied uniformly around the entire circumference of the tube and fittings by a multi-flame torch. Use of oxy-acetylene cutting torch in lieu of multi-flame torch is not permitted. Disassemble valves and other accessories that may be damaged by heat before soldering.

3.3 TESTING OF PIPING SYSTEMS:

A. Each piping system, after erection, shall be subjected to a pressure test. The test requirements shall be as follows:

1. General: Furnish everything required for the tests. Notify Architect/Engineer at least 48 hours before any testing is performed. Independent Agent/Owner shall verify pressure test and sign off. Report to be furnished to Architect/Engineer. Testing shall be performed at the completion of each phase of the project.
2. HVAC related systems shall be tested with water at 1-1/2 times the system working pressure, but not less than 100 psig. Joints will be visually examined for leaks.

a. Initial Hydrostatic Test: Before insulation is applied to field connections, hydrostatically pressure test each pipe as a complete unity with fresh water to 150 psig or not less than 1.5 times systems pressure rating, whichever is greater. Pressure testing with air will not be permitted, unless approved prior to testing. Limit pressure rise to 100 psi per minute at beginning of test and pressure drop to 100 psi at conclusion of test. Remove air from system before start of tests. Pressure must hold for a minimum of four (4) hours with a 4-psi maximum drop. The BCCO should be noticed 72 hours in advance of the test when the final 15-30 minutes of the test will be occurring for their observation. Examine system for leaks and porosity. Replace porous sections and repair leaks in accordance with pipe manufacturer’s instructions, repeat tests until system is proven tight. During a 4-hour pressure holding period, valve off system and completely disconnect method of system pressurization.

b. Cycle Test: Pressure cycle test system at 150 psig or 1.5 times system pressure rating, whichever is greater, for 10 cycles. Each cycle shall consist of a one-minute period at 150 psig or 1.5 times system pressure rating and a 4-minute period when the pressure is dropped at least 40%. Examine system for leaks and porosity, repair leaks, replace porous

pipe, and repeat test until system is proven tight.

c. Post Cycle Hydrostatic Test: Repeat initial hydrostatic test.

d. Operational Test: Operate complete system with water flowing through system. During 48 hours, cycle system 8 hours on and 8 hours off for 3 complete cycles. Examine system for leaks until system is proven tight.

e. Second Hydrostatic Test Series: After successful completion of operational testing, repeat first hydrostatic test series sequence. Examine pipe system for leaks and porosity. Repair leaks, replace porous pipe, and repeat test until system is proven tight. After successful completion of the second hydrostatic test series, backfill trenches.

f. Final Hydrostatic Test: After completion of the final phase of construction, repeat the initial hydrostatic test on the entire piping system(s).

3. Leaks, if any, shall be located, repaired, and retested in accordance with the test method specified for the system in which the leaks are located.

B. Prior to testing a system, the Contractor shall provide the proper Building Official and the Owner's Representative with not less than 72 hours notice of the proposed test. The Contractor shall obtain approval of the test results. Where written approval is required, the Contractor shall obtain such written approval, and submit a copy of the approval.

C. Work requiring testing shall not be covered, or otherwise concealed, until testing is completed and approval is granted.

D. Work, or portions of work, that is altered in any way after testing and approval shall be retested, witnessed, and approval obtained.

E. Systems requiring hydrostatic tests shall be protected from damage caused by freezing. After tests are completed drain all sections of pipe, including traps, or fill undrained sections and traps with antifreeze solution. Vent all high points to release vacuum and ensure complete drainage of closed systems, and blow out piping with compressed air to remove trapped water.

F. Duration of tests, unless specified otherwise, shall be the time required to examine each joint in the system being tested.

G. Systems requiring hydrostatic testing under pressure shall be vented at high points to ensure that all piping is completely filled with the testing medium.

H. Disconnect pressure boosting apparatus, or vacuum pumps, during the test time span specified for systems employing the pressure loss/time span test method.

I. During tests, isolate system components that have test pressures less than pressures specified for system tests.

J. Use clean soapy water applied to exterior of joints to locate leaks in systems using compressed air, dry carbon dioxide, or nitrogen, under positive pressure as a test medium.

3.4 CLEANING OF PIPING SYSTEMS

A. HVAC Piping systems shall be thoroughly cleaned as described in Section 23 25 00 – HVAC Water Treatment.

END OF SECTION 23 21 13

SECTION 23 23 00 - REFRIGERANT 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 WORK INCLUDED

A. Refrigerant (RS/RL/RHG) Piping.

B. Valves and Specialties

1.3 DEFINITIONS

A. The pipe sizes given in this document shall be construed as nominal pipe sizes.

1.4 QUALITY ASSURANCE

A. All material provided under this section shall be standard catalogued products of recognized manufacturers regularly engaged in the production of such products, and shall be of the manufacturer's most recent design that is in regular production.

B. Each item provided under this section shall meet the requirements for that item as installed and used, in accordance with the following standards:

1. Metallic Piping Systems employing mechanical joints and grooved-end pipe - ASME/ANSI B-31.9
2. Refrigeration Piping and Heat Transfer Components - ASME/ANSI B31.5
3. Safety Code for Refrigeration Systems – ASHRAE 15
4. Refrigerant Containing Components and Accessories – UL 207

C. Each piping system shall be in accordance with the system design pressures shown in paragraph 2.1 - Materials, this specification section.

D. All materials provided under this section shall be new, except where the specifications and/or drawings permit the reuse of certain existing materials.

1.5 SUBMITTALS

A. Materials List: Submit a list identifying the specific type of material that will be used for each piping system. Include pipe, pipefittings, valves and joints. Include the basic designation of the publication applicable for each type of material and method.

B. Refrigeration Piping Requirements: Submit a letter from the refrigeration equipment manufacturer stating that the refrigeration piping system, as shown on the contract documents, is acceptable for the equipment the manufacturer proposes to furnish, or submit drawings prepared by an authorized representative of the refrigeration equipment manufacturer.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Refrigerant (RS/RL/RHG) Piping.
System Design Pressure: 300 psig.

1. Piping carrying Refrigerants shall be ACR copper.
2. ACR Copper Refrigerant Piping:

a. Piping, 3" and smaller: Type ACR annealed copper tubing, ASTM B280, ANSI H23.1.
b. Fittings, 3" and smaller, all types, wrought copper: ASTM B16.22, ANSI B16.22. All 90° elbows shall be the long radius type.
c. Brazing: Contractors Option:

(1) 5% silver, 6% phosphorus, balance copper, 1190°F melting point. AWS A5.8 number BCuP -3. J.W. Harris Stay-Silv® 5 or equal.
(2) 15% silver, 5% phosphorus, balance copper, 1190°F melting point. AWS 5.8 number BCuP-5. J.W. Harris Stay-Silv® 15 or equal.
(3) 6% silver, 6.1% phosphorus, balance copper, 1190°F melting point. QQ-B-654A number BCuP -5. J.W. Harris Dynaflow® 5 or equal

d. Unions used shall be specifically designed for refrigeration piping.

2.2 VALVES AND SPECIALTIES

A. Solenoid Valves:

1. Liquid line shut off.
2. Normally closed.
3. Manual lift stem.
4. Pilot operated.
5. Synthetic seat for permanent tight shut off.
6. 120 volt solenoid coil (interchangeable).
7. Top grade brass, bronze and/or semi-steel body materials.
8. Acceptable Manufacturers: Sporlan, Alco, Hubbell, Phillips, Henry.

B. Filter Drier:

1. Replaceable core type.
2. Heavy steel, cadmium plated with external coat of paint.
3. All internal parts cadmium plated.
4. Outlet seal gasket with spring to prevent bypassing.
5. Copper fittings brazed to steel shell, suitable for soldering with Sil-Fos or Phos-Copper solder.
6. Molded porous core elements.
7. Tie rod assembly to permit external assembly with one piece insert.
8. Bolt and nut attachment.
9. Size for refrigerant capacity and tonnage at 2 psi pressure drop.
10. Acceptable Manufacturers: Sporlan, Alco, Hubbell, Phillips, Henry.

C. Moisture and Liquid Indicators:

1. Suitable for R-410A.
2. Accurately calibrated to change color for indication of moisture.

3. Large full view sight glass.
4. Removable indicator element for sizes 1-3/8" and up. Remove before soldering.
5. Full line size for liquid lines up to 2-1/8" O.D. 3/8" bypass indicator with preformed installation kit on larger sizes.
6. Acceptable Manufacturers: Sporlan, Alco, Hubbell, Phillips, Henry.

D. Sight Glasses:

1. Similar to Sporlan "See-all" moisture and liquid indicator with solder type connections.
2. Install sight glass of the same size as the liquid line.

E. Miscellaneous Valves and Accessories:

1. Drain valves for all pressure vessels.
2. Dual pressure relief valves with manifold for all pressure vessels.
3. Refrigerant service valves where indicated.
4. Pressure - Temperature Test Ports and Test Kit:

    a. Brass or stainless steel body with threaded cap and gasket.
    b. Two self closing valves with intermediate pocket for added pressure protection.
    c. Pressure temperature test kits consisting of 0- 150 psi pressure gauge with adapter, 25-125°F testing thermometer, 0-220°F testing thermometer, gauge adopted and protective carrying case (two required).

F. Thermometers:

1. Red reading type, glass front, iron or phenol case, adjustable pattern, separable socket.
2. Shall have 9 inch scale and 12 inch case.
3. Operating range shall occur in middle half of total range
4. Acceptable Manufacturers: Mueller, Taylor, Rochester.

G. Gauges:

1. Liquid pressure gauges constructed with bronze tube, stainless steel movement, white dial, black micrometer, adjustable pointer, iron case with black flange iron or phenol screwed ring, bottom connection.
2. Case diameter size shall be 4-1/2 inches minimum.
3. Operating range shall occur in middle half of total gauge range.
4. Provide needle valve for all gauges.
5. Acceptable Manufacturers: Crosby-Ashton Type AAO, Ashcroft, Lonegran

H. Refrigerant Charge: Complete operating charge of R-410A.

I. High pressure receiver, designed and constructed for 300 psi design working pressure with liquid seal float control, automatic liquid feed valve, drain and equalizer connections, liquid line filter-drier, moisture indicator, three service and bypass valves, charge valve and manual purge valve.

J. Locking Refrigerant Caps: Precision machined from high grade brass surrounded by a protective aluminum shroud. Provide a 1-year warranty. Provide one multi key per project to maintenance personnel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Furnish and install piping, fittings and appurtenances required to complete the piping systems shown on the drawings. Elbows shall be long radius type. Tees may not be field fabricated.
2. Run piping to true alignment, generally parallel or perpendicular to building walls, floors and ceilings, and with uniform grades and spacing, so as to present a neat and workmanlike appearance.
3. Care shall be paid to the exact locations of piping with respect to equipment, ducts, conduits, slabs, beams, lighting fixtures, columns, ceiling suspension systems, etc. to provide maximum access to mechanical and electrical equipment in the building. Close coordination and cooperation shall be exercised with other trades in locating the piping in the best interests of the Owner. The drawings and specifications covering other work to be done in the building shall be carefully studied and arrangements made to avoid conflict.
4. Not all necessary pipe offsets are indicated on the drawings because of the small scale. The various runs of piping to be installed shall be studied and adjustments made in exact routings as may be required for proper installation.
5. Conflicts arising during the erection of piping shall be brought to the attention of the Owner's Representative. No improvising or field changes will be permitted without the approval of the Owner's Representative.
6. Use full lengths of pipe wherever possible. Short lengths of pipe with couplings will not be permitted. Cut to exact measurement and install without forcing or spring unless otherwise shown on the drawings or specified.
7. Avoid tool marks and unnecessary pipe threads. Burrs formed when cutting pipe shall be removed by reaming. Before installing any pipe, care shall be taken that the inside is thoroughly cleaned and free of cuttings and foreign matter. Measures shall be taken to preserve this cleanliness after erection.
8. Arrange pipe connections to valves and specialties so that there is clearance for easy removal of the valve or specialty from the line, and also for the removal of the valve bonnet and interior, and the specialty top and bottom and interior, except where otherwise approved by the Owner's Representative.
9. Erect piping in such a manner so as to obtain sufficient flexibility and to prevent excessive stresses in materials and excessive bending movements at joints or connections to equipment. Make allowances throughout for expansion and contraction of piping. Provide each riser and horizontal run of piping with expansion loops, expansion joints, or expansion compensators where indicated and required. Securely anchor and adequately guide pipe as required or where indicated to force expansion to the expansion device without bending, binding, or misalignment of pipe. Branch connections from mains to risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Where indicated, in lieu of expansion loops, expansion joints, or expansion compensators, horizontal runs of pipe shall be anchored at approximately midway of the run to force expansion, evenly divided, toward the mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining.
10. Installed piping shall not interfere with the operations or accessibility of doors or windows and shall not encroach on aisles, passageways and equipment, and shall not interfere with the servicing or maintenance of any equipment. Adjacent pipelines shall be grouped in the same horizontal or vertical plane.
11. Where lines are purposely pitched for drainage, an accurate grade shall be

maintained. No lines shall be supported in such a manner as to permit deflection, due to gravity, sufficient to pocket the lines when full of liquid. Grade mains as indicated by arrows on the drawings and in accordance with gradient as indicated in attached Piping Schedule.

12. Piping found to have water hammer or other objectionable vibrations which cannot be eliminated by proper grading or other natural means, shall be braced, trapped or hung with shock absorbing hangers and equipped with air chambers, mechanical shock absorbers, and flexible pipe connections or otherwise silenced using approved means.
13. Use building steel wherever possible for supporting pipe hangers. Main structural steel shall not be drilled, cut or burned for hangers without the approval of the Owner's Representative. Expansion bolts shall be used only upon the approval of the Owner's Representative.
14. Install unions or flanges in piping connections to equipment, regulating valves, and wherever necessary to facilitate the dismantling of piping and/or removal of valves and other items requiring maintenance.
15. Avoid bushings. Reducing fittings shall be used wherever practical.
16. The drawings indicate the size of piping and connections, and if certain sizes are omitted or unclear, obtain additional information before proceeding.
17. The piping drawings have been worked out with a view to the most economical installation, taking into consideration accessibility and appearances, and the Contractor must follow the drawings accurately and if it is found impractical to install the work in accordance with the drawings and specifications, the Contractor shall notify the Owner's Representative before making any changes and get their approval or revised drawings before proceeding with the work. Verify all measurements on the job before cutting pipes or having piping fabricated, and be responsible for the correct location of all pipe connections, also check sizes and standard of outlets on the equipment, including the dimensions and drilling of flanges, etc.
18. Copper tubing and galvanized steel shall not be mixed in any one run of piping.
19. Change in direction shall be made with fittings, except that bending of steel and copper pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations is not acceptable.
20. Threaded joints shall be made with tapered threads in accordance with ANSI B2.1, and made tight with an approved pipe thread joint compound or material, applied to the male threads only. Use compounds sparingly and apply with caution to ensure that compounds do not enter piping systems. When pipe joint is made up a maximum of 3 threads shall be visible.
21. Joints for plastic pipe shall be made in accordance with PPI Piping Manual.
22. Connections between ferrous and nonferrous metallic pipe shall be made with dielectric unions or flanges.
23. Connections between plastic and metallic pipe, between plastic and glass pipe, and between metallic and glass pipe, shall be made with transition fittings manufactured for the specific purpose.
24. Unions and flanges shall not be concealed in walls, partitions, or above inaccessible ceilings.

B. Valve and Specialties Applications

1. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
2. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

3. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
4. Install thermostatic expansion valves as close as possible to distributors on evaporators.

    a. Install valve so diaphragm case is warmer than bulb.
    b. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line. Verify proper location for the bulb with the valve manufacturer
    c. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

5. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety relief-valve discharge line to outside according to ASHRAE 15.
6. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube on each circuit.
7. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

    a. Solenoid valves.
    b. Thermostatic expansion valves.
    c. Hot-gas bypass valves.
    d. Compressor.

8. Install filter dryers in liquid line between compressor and thermostatic expansion valve on each circuit.
9. Install receivers sized to accommodate pump-down charge.
10. Install flexible connectors at compressors.
11. Locking Refrigerant Caps: Provide at all exterior refrigerant service access ports (Schrader valves).
12. Install gauges with dial in vertical position. Locate between shut-off valve and equipment directly adjacent to equipment within normal visual range of operator standing on floor.
13. Provide gauges where shown on drawings, including the following locations:

    a. Ice builders; leaving each builder on the pumped liquid return header.
    b. Barrel chiller; entering and leaving the pumped liquid lines.
    c. Compressor oil coolers; entering and leaving condenser water lines.
    d. Evaporative condenser; entering and leaving refrigerant lines.
    e. Refrigerant pumps; entering and leaving the pumped liquid lines.

14. Provide nickel plated brass escutcheons or floor plates, around pipes piercing floors and walls in finished spaces. Fit around insulation or around pipe if un-insulated. Secure to pipe with setscrew. Provide deep escutcheon where sleeve projects beyond finished surface

C. Refrigerant Systems Additional Requirements:

1. Installation shall be in accordance with ANSI B31.5 Refrigeration Piping, unless specified otherwise herein.
2. Brazing procedures and operators shall be qualified in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.
3. Refrigerant pipeline accessories that may be damaged by heat shall be disassembled prior to joint brazing. Reassemble accessories after joint brazing operations are completed.

4. Joints shall be made with solder-type fittings. The outside surface of the tube where engaged in the fitting, and the inside surface of the fitting in contact with the tube, shall be cleaned with an abrasive material before brazing. Self-cleaning compounds are not allowed. Care shall be taken to prevent annealing of tube and fittings when making connections. Brazed joints shall be made with flux and the previously specified silver-brazing alloy. The brazing alloy shall be applied and drawn through the full fitting length. Excess brazing alloy shall be wiped from the joint before the brazing alloy hardens. Joints shall be made with heat applied uniformly around the entire circumference of the tube and fittings. Remove all excess flux for a clear visual inspection of all brazed connections.
5. Refrigerant piping installed below concrete slab- on-grade shall be installed in continuous runs without joints, and shall be encased in PVC plastic conduit. Ends of conduit shall be sealed watertight.

3.2 BRAZING AND SOLDERING

A. Operator and Procedure Qualifications: All brazing operators and all brazing procedures shall be qualified in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

B. Brazing: Silver braze joints in accordance with MSS-SP-73 "Silver Brazing Joints for Wrought and Cast Solder Joint Fittings".

C. Soldering: Joints in copper tubing shall be made with solder- type fittings. Outside surface of the tube where engaged in the fitting, and inside surface of the fitting in contact with the tube, shall be cleaned with an abrasive material before soldering. Self- cleaning compounds shall not be used. Care shall be taken to prevent annealing of tube and fittings when making connections. The solder joint shall be made with flux and wire form solder, except brazed joints. The flux shall be a mildly corrosive liquid or a petroleum based paste containing chlorides of zinc and ammonium. Solder shall be applied and drawn through the full fitting length. Excess solder shall be wiped from joint before solder hardens. Joints in copper tube sizes 2-1/2 inches and larger shall be made with heat applied uniformly around the entire circumference of the tube and fittings by a multi-flame torch. Use of oxy-acetylene cutting torch in lieu of multi-flame torch is not permitted. Disassemble valves and other accessories that may be damaged by heat before soldering.

3.3 TESTING OF PIPING SYSTEMS:

A. Each piping system, after erection, shall be subjected to a pressure test. The test requirements shall be as follows:

1. General: Furnish everything required for the tests. Notify Architect/Engineer at least 48 hours before any testing is performed. Independent Agent/Owner shall verify pressure test and sign off. Report to be furnished to Architect/Engineer. Testing shall be performed at the completion of each phase of the project.
1. Refrigerant Piping Systems shall be tested with dry carbon dioxide, or nitrogen, at 315 psig for the high side, and at 245 psig for the low side. If leaks are to be detected by use of an electronic halogen detector, or a halide torch, the system shall be pressurized with refrigerant gas prior to introduction of dry carbon dioxide or nitrogen into the system. Pre-charging of system with refrigerant gas is not necessary for soap bubble leak detection method.
3. Leaks, if any, shall be located, repaired, and retested in accordance with the test method specified for the system in which the leaks are located.

B. Prior to testing a system, the Contractor shall provide the proper Building Official and the Owner's Representative with not less than 72 hours notice of the proposed test. The Contractor shall obtain approval of the test results. Where written approval is required, the Contractor shall obtain such written approval, and submit a copy of the approval.

C. Work requiring testing shall not be covered, or otherwise concealed, until testing is completed and approval is granted.

D. Work, or portions of work, that is altered in any way after testing and approval shall be retested, witnessed, and approval obtained.

E. Systems requiring hydrostatic tests shall be protected from damage caused by freezing. After tests are completed drain all sections of pipe, including traps, or fill undrained sections and traps with antifreeze solution. Vent all high points to release vacuum and ensure complete drainage of closed systems, and blow out piping with compressed air to remove trapped water.

F. Duration of tests, unless specified otherwise, shall be the time required to examine each joint in the system being tested.

G. During tests, isolate system components that have test pressures less than pressures specified for system tests.

H. Use clean soapy water applied to exterior of joints to locate leaks in systems using compressed air, dry carbon dioxide, or nitrogen, under positive pressure as a test medium.

END OF SECTION 23 23 00

SECTION 23 25 00 - HVAC WATER TREATMENT

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 WORK INCLUDED

A. Feeding and Control Equipment with all Piping and Wiring for each System.

B. Pre-Operation Cleaning of each System.

C. Initial Water Analysis and Recommendations.

D. Water Treatment Chemicals for each System.

E. Test Equipment.

F. Training of Operating Personnel Including Written Instructions, Log Sheet and Record Forms.

G. Follow-up service for one (1) full year from date of start-up including laboratory assistance.

1.3 SYSTEMS TO BE TREATED

A. Chilled Water (CHS/CHR).

1.4 QUALITY ASSURANCE

A. All electrical components shall be UL or ETL listed or labeled.

B. All wiring shall conform to the NEC.

C. The pre-cleaning and chemical charging shall be by or supervised by personnel trained in the field of water treatment. Chemicals shall be charged into the system within 24 hours of flushing and during circulation.

D. All chemicals shall be compatible with system materials of construction and shall comply with all applicable EPA and regulatory agency standards.

E. After charging of the system and for a period of one (1) full year after the date of start up the water treatment supplier shall periodically inspect the system and perform all necessary tests (minimum of 4) to properly evaluate the chemical concentration.

F. After completion of the system the water treatment supplier shall train the owner in the proper maintenance procedures and future system requirements.

G. After completion of the system water treatment, the contractor shall provide a water analysis and certify in writing to the Owners Representative and Engineer of Record that the system or systems have been properly flushed, cleaned and charged with the proper chemical concentration and that the Owner has been instructed in proper maintenance procedures.

H. Corrosion coupon analysis by manufacturer's laboratory with test report at the end of the first year of operation.

1.5 SUBMITTALS

A. Submit schedule indicating make, model and size by system.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

C. Submit in accordance with Division 01 Requirements.

D. Submit letter of certification as described in 1.4.G.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. American Water Chemicals, Inc.

B. AquaTrol™ Division of Momar, Inc.

C. Betz

D. Chem Aqua.

E. Chem-Treat, Inc.

F. Nalco

G. Southeast Water Labs

2.2 PIPING SYSTEMS AND WATER TREATMENT SYSTEMS

A. Chilled Water (CHS/CHR) : Closed Loop

2.3 WATER TREATMENT REQUIREMENTS

A. Closed Loop:

1. General: Manual feeding of chemicals into filter style shot feeder and in turn into system in accordance with initial water evaluation and continuing test result requirements.

2. Feeding and Control Equipment:

a. Five gallon combination filter-feeders, quantity as shown on drawings. Equal to Efficiency Dynamics, Ft. Worth, TX 76101, FF- 100, including steel shell with stainless steel basket, filter bag capable of 40 gpm flow with filter efficiency of 5 microns at 3 psi pressure drop and hand removable cap. Suitable for 150 psi and temperatures to 200°F.
b. Twelve filter bags or provide one (1) if filter is cleanable.
c. Corrosion coupon assembly rack including corrosion probe connection fittings, one carbon steel and one copper corrosion coupon with holders and two (2) corrosion coupon tees.

d. Totalizing make-up water meter equal to Master Meter Multi-Jet for installation in make-up water line. Meter to be sized per the plumbing drawings and shall have contacts for monitoring by the Building Control System.
e. Installation accessories including piping, fittings, shut off valves, drain valves, pressure gauges to measure pressure loss thru filter and automatic flow control valve set for 8 GPM as specified in Section 23 05 19 - Meters, Gages and Accessories for HVAC Piping.

3. Water Treatment Chemicals:

a. All chemicals necessary for flushing and pre- cleaning.
b. All chemicals, in liquid form, necessary to control scale, corrosion, microbiological growth and water PH. Quantity to last 1 full year from date of start up.

2.4 TEST EQUIPMENT

A. Test equipment to properly evaluate the chemical levels within the system. The test equipment shall include but not be limited to: Carrying case or cabinet, all necessary reagents for determination of corrosion inhibitor level pH, P & M, alkalinity and chlorides as well as microbiological colony population and biocide effectiveness.

PART 3 - EXECUTION

3.1 GENERAL

A. Each piping system is to be provided with the specified hardware. Where multiple evaporative condensers or closed circuit fluid coolers are specified, each is to be provided with its own chemical feed equipment.

B. All products shall be installed or services performed in strict accordance with the manufactures written installation/procedure instructions.

C. The contractor is responsible for all bypassing equipment, piping, pumps and temporary connections required to flush the entire piping system. Flushing through HVAC equipment such as, but not limited to AHU coils, chiller evaporator barrels, control valves, heat exchangers, permanent pumps, etc. is NOT acceptable.

D. The following steps, for cleaning water piping systems, are based on using sodium nitrite, azole, and sodium hydroxide as the closed system corrosion inhibitors and are intended to be indicative of the care to be taken. Prior to cleaning the system, require the contractor to submit a “pipe system cleaning plan”; include a cleaning sequence not less stringent than the following in the project specifications. Selection of the chemicals to be used shall be in consultation with the treatment provider.

E. Perform initial flush with fresh water to remove sediment and suspended solids. Provide temporary bypass for coils and associated control valves for initial flush. Remove bypass for following flush sequences. Flush system mains at 10 FPS and branch piping at 15 FPS.

F. Once the initial flush is complete and the water is clear, add the alkaline cleaner and circulate for 24 hours. Commence “feed and bleed” to flush out the system. All wyes and system strainers will be verified as clean during this detergent flush. All control valves will be manually or automatically opened to ensure flow through all equipment during cleaning

and flush. Describe the procedure used to accomplish this in the water treatment records.

G. Refill system with fresh water, and circulate for 4 hours. Discard this rinse water and refill the system with clean water. When the pH of the system water matches the pH of the make-up water, and the system water is clear, add corrosion inhibitor immediately in sufficient quantity to provide solution prescribed by water treatment specialist (typically, 800-1200 PPM for sodium nitrite). Ensure that total iron in the closed loops, including dissolved and non-dissolved iron is less than 1 PPM. If total iron exceeds 1 PPM, continue flushing until this value drops below 1 PPM. Failure to maintain system water as clear and total iron below 1 PPM will subject the mechanical contractor to repeating this flushing and treatment process at the direction of the owner. After the initial manual addition of closed loop corrosion inhibitor, the mechanical contractor will run the system to circulate the system water continuously for 96 hours. Take water treatment samples and record results to ensure inhibitor concentration is maintained at prescribed level.

H. Orange County maintenance and operations representative or Commissioning Agent, as well as owner’s Construction representative, shall attest in writing to the detergent flush, rinse, and initial addition of nitrite.

I. Contractor shall ensure that inhibitor levels are maintained at all times in all closed loops. This is subject to random verification and back-charges to mechanical contractor for required services to immediately correct, as well as penalties for any system corrosion allowed to establish in the loops. Contractor shall ensure that total iron levels will be maintained below 1 PPM at all times in all closed water loops, including chilled water, hydronic, 2-pipe systems and water side heat pump systems.

J. Contractor shall certify, by field test, that closed loops have adequate inhibitor (800 PPM minimum for nitrite). Orange County operations & maintenance representative or Commissioning Agent must be present and attest to proper conditions met as a component of substantial completion acceptance. Orange County operations & maintenance may bring their own representative to test and verify water chemistry and proper system conditions.

K. Contractor shall maintain records of dates of initial detergent flush, system rinse, and initial inhibitor type and amount added to the system. In addition, water treatment contractor shall provide monthly reports to the Engineer of Record and Orange County, including one copy to the area maintenance manager, attesting to proper conditions in closed loops for the project. Contractor shall maintain logs of monthly or more frequent readings of make-up water meters. Contractor shall ensure retesting of inhibitor levels within three days of significant water use or loss in closed loops. Contractor shall maintain records of retesting required by water loss from closed loops.

L. After the system is flushed, pre-cleaned and chemically stabilized the Contractor shall:

1. Turn the test kits over to the owner.
2. Instruct the owner in proper maintenance procedures.
3. Fulfill all obligations for the specified period of one (1) full year from the date of start up including four (4) service calls during the cooling season and two (2) service calls during the heating season.

M. Where the owner provides the chemicals for treatment, notify the owner well in advance of the cleaning process and when completed, advise in writing that it is recommended that the chemicals be charged immediately to prevent damage to the system.

END OF SECTION 23 25 00

SECTION 23 31 00 - HVAC DUCTS AND CASINGS

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 WORK INCLUDED

A. Single Wall Round Ductwork and Fittings.

B. Single Wall Round Snaplock Seam Galvanized Steel Ductwork and Fittings.

C. Single Wall Round Flexible Ductwork.

D. Insulated Round Flexible Ductwork.

1.3 QUALITY ASSURANCE

A. All ductwork shall be fabricated within the guidelines established by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) HVAC Duct Construction Standards - Metal and Flexible, latest edition.

B. All ductwork shall be fabricated to withstand the pressure and velocity required on this project.

C. All components, fasteners, sealants, adhesives, etc. in the conditioned air stream or exposed in active or non- active plenums shall conform to the NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems and Standard for Flame/Smoke/Fire Contribution of 25/50/0.

D. All ductwork shall conform to UL standard UL 181 Factory Made Air Duct Materials and Duct Connectors, latest edition. Applicable sections shall apply to shop fabricated ductwork.

E. After fabrication and installation of all shop fabricated ductwork the fabricator and installer, if not the same, shall certify in writing to the Owner's representative and Engineer of Record that all shop fabricated ductwork and installation of same meets or exceeds the quality standards established by SMACNA.

1.4 SUBMITTALS

A. Submission for acceptance is required. Submit in accordance with Division 01 for submittal requirements.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

1.5 SHOP DRAWINGS

A. Shop Drawings: Provide shop drawings of ductwork as follows:

1. Draw to a scale of not less than 1/4 inch to one foot on the same size sheets as the contract drawings.

2. Show duct sizes.
3. Show fitting details.
4. Show lighting and ceiling diffusers.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Single Wall Round Ductwork and Fittings:

1. Autoduct, Inc.
2. Crown Products Company
3. Eastern Sheetmetal
4. Hamlin Sheetmetal, Inc.
5. Impulse Air.
6. Lindab
7. Semco Manufacturing, Inc.
8. Snap-Rite
9. United McGill

B. Single Wall Round Snaplock Seam Galvanized Steel Ductwork and Fittings:

1. Alco Manufacturing Company.
2. Crown Products Company.
3. Hughes.

C. Single Wall Round Flexible Ductwork:

1. ATCO Rubber Products, Inc.
2. Flexmaster USA, Inc.
3. Flexible Technologies - Thermaflex®
4. Gray Flex Systems, Inc.

D. Insulated Round Flexible Ductwork:

1. ATCO Rubber Products, Inc.
2. Flexmaster USA, Inc.
3. Flexible Technologies - Thermaflex®
4. Gray Flex Systems, Inc.

2.2 FABRICATION

A. Single Wall Round Ductwork and Fittings:

1. Materials: Hot rolled, continuously annealed, hot dipped galvanized steel minimum of G-90, 0.90 oz/sf coating, conforms to ASTM A653.
2. Metal Gauges: Conform to the Sheet Metal and Air Conditioning Contractor's National Association, Inc. (SMACNA) HVAC Duct Construction Standards - Metal and Flexible, latest edition. The following table shall establish a minimum guideline unless the manufacturer has U.L. Standard 181 test results that show that lighter gages (thinner wall thickness) with intermediate corrugations (ribs) allow the gage reduction:

Pipe Diameter	Positive Internal Static Pressure in W.G.					
	0" - 2.0"		2.1" - 4.0"		4.1" - 10.0"	
	Spiral Pipe	Fittings	Spiral Pipe	Fittings	Spiral Pipe	Fittings
6" - 10"	28	26	28	24	28	24
12"	28	26	28	24	26	24
14"	28	26	26	24	26	24
16"	26	24	26	22	24	22
18" - 26"	26	24	24	22	24	22
27" - 36"	24	22	22	20	22	20
37" - 50"	22	20	20	20	20	20
51" - 60"	20	18	18	18	18	18
61" - 84"	18	16	18	16	18	16

3. Duct Construction: Spiral wound, lockseam construction, slip joint or flanged connections as noted below under couplings.
4. Fitting Construction:

    a. 90 Deg. and 45 Deg. Ells: Solid - welded seam construction for dust collector use, Solid - welded seam or spot welded and bonded for general use. Radiused ells to be full radiused unless otherwise noted, mitered ells to have single thickness, turning vanes, slip joint or flanged connections.
    b. Tees or Crosses: Solid - welded seam construction for dust collector use, Solid - welded seam or spot welded and bonded for general use. Tangential, unless otherwise noted or detailed, conical take off or reduction, slip joint or coupled ends. 180 Deg. or 45 Deg. as indicated.
    c. Bellmouth: Solid - welded seam construction for dust collector use, Solid - welded seam or spot welded and bonded for general use. Spun metal, smooth converging bellmouth, round, gauge equal or greater than connecting duct.
    d. Access Section:

        1) 7" Diameter and Less: Minimum 12" long flanged section, minimum four bolts per flange.
        2) 8" Diameter and Larger: Round or rectangular access cover, on welded raised section, pressure sensitive release suitable for manual release or emergency vacuum release, chain retainer, (see Para. 3.5: Schedules for Sizes).

    e. Couplings:

        1) Joints 36" or less shall have 2" slip coupling.
        2) 38" or over shall be spiral mate.

    f. Based on United McGill

B. Single Wall Round Snaplock Seam Galvanized Steel Ductwork and Fittings:

1. Materials: Hot rolled, continuously annealed, hot dipped galvanized steel minimum of G-90, 0.90 oz/sf coating, conforms to ASTM A653.
2. Metal Gauges: Minimum of 26 gauge, with remaining sizes conforming to the Sheet Metal and Air Conditioning Contractor's National Association, Inc.

(SMACNA) HVAC Duct Construction Standards Metal and Flexible, latest edition. The following table shall establish a minimum guideline:

Round Ducts:

Duct Diameter	Spiral Pipe	Fittings and Longitudinal Seam Pipe
3" thru 14"	26	24
15" thru 26"	24	22
27" thru 30"	22	20

3. Duct Construction: Snaplock seam construction, slip joint or flanged connections.
4. Fitting Construction:

   a. 90 Deg. and 45 Deg. Ells: Adjustable ells to be full radiused unless otherwise noted, slip joint or flanged connections.
   b. Tees or Crosses: Adjustable, unless otherwise noted or detailed, conical take off or reduction, slip joint or coupled ends. 180 Deg. or 45 Deg. as indicated.

C. Uninsulated Round Flexible Ductwork:

1. High Pressure Application: Factory fabricated assembly of a trilaminate of aluminum foil, fiberglass and polyester with a perm rating of .05 high tear strength and properties to resist temperature change, mildew and age hardening. It shall be mechanically locked, without adhesives, into a formed aluminum helix on the ducts outside surface and be U.L. listed 181 Class 1 and comply with NFPA 90A and 90B. The material shall have a pressure rating of 12" w.g. positive pressure and -5" w.g. negative pressure through a temperature range of -20°F to +250°F. Based on Type NI-35 as manufactured by Flexmaster U.S.A., Inc., ATCO Rubber Products UPC #7 or Flexible Technologies – Thermaflex S-LP-10.

D. Insulated Round Flexible Ductwork:

1. High Pressure Application:

   a. Factory fabricated assembly of a trilaminate of aluminum foil, fiberglass and polyester with a perm rating of .05, high tear strength and properties to resist temperature change, mildew and age hardening. It shall be mechanically locked, without adhesives, into a formed aluminum helix on the ducts outside surface and be U.L. listed 181 Class 1 and comply with NFPA 90A and 90B. The material shall have a pressure rating of 12" w.g. positive pressure and -5" w.g. negative pressure through a temperature range of -20°F to +250°F.
   b. The duct material shall be factory wrapped in a blanket of fiberglass insulation with a C factor of .23 or less. The insulation shall be encased in a fire retardant reinforced aluminum material vapor barrier with a perm rating of not over .05 grains per square ft. per hour per inch of mercury.
   c. Based on Type 3M as manufactured by Flexmaster U.S.A., Inc., ATCO Rubber Products UPC #036 or Omni Air 1200, or Flexible Technologies – Thermaflex M-KF.

2. Low Pressure Application:

   a. Factory fabricated assembly of a trilaminate of aluminum foil, fiberglass and polyester with a perm rating of .05, high tear strength and properties

to resist temperature change, mildew and age hardening. It shall be mechanically locked, without adhesives, into a formed aluminum helix on the ducts outside surface. It shall be U.L. listed 181 Class 1 and comply with NFPA 90A and 90B. The material shall have a pressure rating not less than 6" w.g. positive pressure and -3" w.g. negative pressure through a temperature range of -20°F to +250°F.

b. The duct material shall be factory wrapped in a blanket of fiberglass insulation with a C factor of .23 or less. The insulation shall be encased in a fire retardant reinforced aluminum material vapor barrier with a perm rating of not over .05 grains per square ft. per hour per inch of mercury.

c. Based on Type 5M as manufactured by Flexmaster U.S.A., Inc., ATCO Rubber Products UPC #036 or Omni Air 1200, or Flexible Technologies – Thermaflex M-KF.

G. Ductwork, General: Each duct section shall have both ends covered with polyethylene or other suitable material to protect against the entrance of dirt, debris or water during shipment and storage prior to installation.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS:

A. Install in strict accordance with the manufacturer's written installation instructions.

B. The drawings, due to their small scale, are diagrammatic in nature and are not necessarily complete in all details. For this reason not all necessary offsets, rises or falls are shown. Coordinate the installation of the ductwork with all other trades and to provide all necessary offsets, etc. as required for completion of this project without any additional cost to the Owner, Architect or Engineer.

C. All ductwork shall be run parallel or perpendicular to building structure and seams or spirals shall be aligned whenever possible.

D. All sizes indicated on the drawings are inside clear dimensions.

E. All ductwork shall be properly sealed in a neat clean manner with all excess sealer wiped clean.

F. Coordinate the location of, provide the necessary access and install all devices provided in other specification sections within Division 23, including but not limited to fire, smoke and/or balancing dampers, access and mounting for control devices, air flow measuring stations, etc., as apply to this project.

G. All ducts passing through partitions or walls shall be properly and neatly sealed. If partition or wall carries a fire rating (fire damper indicated or if architectural plans indicate a rated wall) the duct shall be sleeved with the space between the sleeve and duct properly sealed with firestopping material under Division 07. The sleeve shall be permanently affixed to the wall (see Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment for sleeve specification).

H. Coordinate the proper duct pressure classification with the system served and to provide the proper ductwork to withstand these pressures. (See Para. 3.5 Schedules: System Pressure Classification and Duct Material Schedule.)

3.2 CLEANING AND PROTECTION

A. During construction, ductwork shall be cleaned of dirt and debris internally section by section as it is installed. At end of each day, ductwork not finally connected to equipment shall be provided with a temporary closure of polyethylene film or other covering material that will prevent entrance of dust, debris or water. Clean exterior surfaces of any material which might cause corrosion or if the duct is to be painted, it shall be cleaned suitable for painting. After substantial completion of the ductwork system the system shall be operated with filters in place to blow-out any remaining dust from the system. Protect all equipment and property from damage or fouling during this cleaning. All prefilters used during cleaning shall be replaced prior to turning the system over to the Owner.

3.3 LEAK TESTING

A. Duct Leakage Report: The Contractor shall make all the supply, return, outside air, and exhaust duct systems (limited to 1,500 cfm and greater) operationally air-tight, with no more than 10% leakage for duct systems rated at 2" w.c. pressure class, and 5% leakage for systems exceeding 2" w.c. pressure class.

1. Refer to specification section 23 05 93 – Testing, Adjusting and Balancing for HVAC for more information.

3.4 INSTALLATION

A. General:

1. Install generally as indicated.
2. Conceal ductwork in finished spaces unless indicated otherwise.
3. Do not install ductwork in or allow entering or passing through electrical rooms, elevator machine room, or spaces housing switchboards, panelboards or distribution boards, except ductwork that serves electrical rooms, elevator machine rooms or spaces.
4. Exercise special care to provide tight fitting well fabricated, well braced ductwork systems.
5. Field assemble rectangular, round or flat oval ductwork as follows:

    a. Use slip joints, couplings, etc. sealed with adhesive pre-applied to couplings or duct mate spiralmate or oval mate on duct sizes 1” and larger.
    b. Isolate dissimilar metals with elastomeric sealant tape or fiber gaskets and gaskets and washers for bolts.

6. In high pressure ductwork (above 2" w.g.), do not use 2 piece mitered 90 degree elbows with or without vanes unless approved by engineer.
7. Make duct connections from hoods, openings, fans and other devices.

B. Uninsulated Round Flexible Ductwork:

1. Provide where indicated or required on return air duct connections only.
2. Maximum length shall be 5'-0".
3. Maximum turn or bend shall be no more than 90 Deg. Provide rigid elbows where 90 Deg. turns are indicated on the drawings.
4. Flexible ductwork shall be cut to the proper length. Coiling or unnecessary offsets will not be permitted.
5. Secure inner liner to terminal collar or duct coupling with duct sealer and sheet metal screws. Wrap with three wraps of duct tape following helix path.
6. Rigid round ductwork may be substituted in lieu of flex unless the flex duct is used for vibration isolation or otherwise detailed.

C. Insulated Round Flexible Ductwork:

1. Provide where indicated or required on supply air ducts.
2. Coordinate the insulation requirements as to assure a continuous and consistent thermal resistance and vapor barrier.
3. Maximum length shall be 5'-0".
4. Maximum turn or bend shall be no more than 90 Deg. Provide rigid elbows where 90 Deg. turns are indicated on the drawings or more than one 90 Deg. turn is required.
5. Flexible ductwork shall be cut to the proper length. Coiling or unnecessary offsets will not be permitted.
6. Secure inner liner to terminal collar or duct coupling with duct sealer and sheet metal screws. Provide Stainless steel draw band to seal inner liner tight to connecting duct. Pull insulation over inner liner and fold vapor barrier over end of insulation. Secure with two coats of an approved vapor barrier mastic, reinforced with glass cloth extending 2 inches onto adjacent insulation. One coat of mastic shall be applied to the insulation prior to the application of the glass cloth, which shall be embedded in the mastic to ensure complete adhesion of the cloth.
7. High pressure flexible duct to be provided upstream of all terminal boxes. Low pressure flexible duct may be used downstream of terminal box.
8. Rigid round ductwork may be substituted in lieu of flex unless the flex duct is used for vibration isolation or otherwise detailed. If omitted, external insulation must be provided per Section 23 07 00 – HVAC Insulation.

3.5 SCHEDULES

A. System Pressure Classification and Duct Material Schedule:

System I.D. No.	System	Section	Maximum Pressure	Duct Material
1.	Supply	AHU to Terminal	3" pos.	A
2.	Supply	Terminal to Diffuser	1" pos.	A
3.	Return	Terminal to AHU	2" neg.	A

Schedule Legend:
Duct Material

A Galvanized Steel

B. Access Door Schedule:

1. Round Duct:

	Duct Size	Access Door Size
a.	up to 7" dia.	12" long removable section
b.	8" to 12" dia.	8" x 12"
c.	13" to 18" dia.	12" x 12"
d.	19" dia. and up	14" x 20"

END OF SECTION 23 31 00

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SECTION 23 31 01 - SHOP FABRICATED DUCTWORK

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. Refer to Division 07 for all requirements pertaining to firestopping materials.

1.2 WORK INCLUDED

A. Galvanized Steel Rectangular Ductwork.

1.3 QUALITY ASSURANCE

A. All ductwork shall be fabricated within the guidelines established by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) HVAC Duct Construction Standards - Metal and Flexible, latest edition.

B. All ductwork shall be fabricated to withstand the pressure and velocity required on this project.

C. All components, fasteners, sealants, adhesives, etc. in the conditioned air stream or exposed in active or non- active plenums shall conform to the NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems and Standard for Flame/Smoke/Fire Contribution of 25/50/0.

D. All ductwork shall conform to UL standard UL 181 Factory Made Air Duct Materials and Duct Connectors, latest edition. Applicable sections shall apply to shop fabricated ductwork.

E. After fabrication and installation of all shop fabricated ductwork the fabricator and installer, if not the same, shall certify in writing to the Owner's representative and Engineer of Record that all shop fabricated ductwork and installation of same meets or exceeds the quality standards established by SMACNA.

1.4 SUBMITTALS

A. Submission for acceptance is required. Submit in accordance with Division 01 requirements.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

1.5 SHOP DRAWINGS

A. Shop Drawings: Provide shop drawings of sheet metal ductwork as follows:

1. Draw to a scale of not less than 1/4 inch to one foot on the same size sheets as the contract drawings.
2. Show duct sizes.
3. Show fitting details.
4. Show lighting and ceiling diffusers.

B. Floor Plans: Provide sheet metal floor plans drawn to the same scale as the contract drawings.

1. Use contract drawing sheet size.
2. Show on each floor plan the floor penetrations, fire dampers and access doors, ducts with sized and bottom elevations, terminal types and air quantities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Galvanized Steel Ductwork:

1. Interior, exposed or concealed: Hot rolled steel continuously annealed and hot dipped galvanized sheet or coil, minimum G-90, 0.90 oz/sf coating suitable for forming without flaking or peeling, suitable for welding or soldering. Zinc coating shall not be impaired from double seaming, breaking or roll forming. 14 ga. and lighter conforming to ASTM A653. 13 ga and heavier conforming to ASTM A653.
2. Exterior or Areas Requiring Painting: Hot rolled steel continuously annealed and hot dipped galvanized sheet or coil, minimum G-90, 0.90 oz/sf (.001 inch thick/side) coating with a mill applied phosphate film suitable for insulating the paint from the drying action of the zinc, capable of forming without flaking or peeling, suitable for welding or soldering. Zinc coating shall not be impaired from double seaming, breaking or roll forming. 14 ga. and lighter conforming to ASTM A653. 13 ga. and heavier conforming to ASTM A653.

2.2 FABRICATION

A. Galvanized Steel Ductwork:

1. Fabricate ductwork as indicated on the drawings. Sizes given are inside clear dimensions. Allowances must be made for duct liner if indicated. Unless otherwise indicated on the drawings, the metal gauge shall be in accordance with SMACNA-HVAC Duct Construction Standards - Metal and Flexible, Latest Edition.

2. Elbow Fabrication:

a. 90 deg. elbows 12" or less in width shall be radiused whenever possible.
b. All radiused elbows shall be full radiused (R=1.5).
c. All mitered 90 deg. elbows shall have turning vanes. Ducts with a width/depth ratio of 1 or more shall have double thickness turning vanes; single thickness is permissible for less than 1.

3. Tee or Take-off Fabrication:

a. Take-off to round run-outs shall be conical or bell mouth. Where conical or bellmouth fittings can not be used due to take-off size to main, provide factory fabricated side takeoff fitting equal to Flexmaster U.S.A., Inc. Type “STO”. Provide with handle extension for insulated ducts to clear the insulation thickness specified.
b. Take-off to square or rectangular shall be 45 deg. clinch collar or proportional divisions.
c. A volume damper shall be located downstream of each take off on square and rectangular take-offs, and integral to round run-outs.

4. Transitions:

   a. Concentric Transition: Maximum angle 45 deg. diverging, 60 deg. converging (SMACNA Fig. 2-7).
   b. Eccentric Transition: Maximum angle 30 deg. diverging or converging (SMACNA Fig. 2-7).

5. At the Contractor’s option, ductwork may be joined at the transverse joints with prefabricated galvanized Ductmate Industries, Inc. (”25" or “35") or Ward Industries, Inc. sections, or with fabricated TDF or TDC T-24 type flanged transverse joints with bolted corners, gaskets, and sealants, constructed in accordance with the SMACNA HVAC Duct Construction Standards - Metal and Flexible, latest edition, Table 1-12. Ductmate “25" may be used only on ductwork with a pressure classification of 2" w.g. or less on the discharge side of air handling units or fan power terminal units. Plastic joint clips are not acceptable. Flanged and prefabricated joints by different manufacturers shall not be jointed. Formed on flanges shall not be used.

B. Ductwork, General: Each duct section shall have both ends covered with polyethylene or other suitable material to protect against the entrance of dirt, debris or water during shipment and storage prior to installation.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Install in strict accordance with the Sheet Metal and Air Conditioning Contractor's National Association, Inc.'s (SMACNA) recommendations.

B. The drawings, due to their small scale, are diagrammatic in nature and are not necessarily complete in all details. For this reason not all necessary offsets, risers or falls are shown. Coordinate the installation of the ductwork with all other trades and to provide all necessary offsets, etc. as required for completion of this project without any additional cost to the Owner, Architect and/or Engineer.

C. All ductwork shall be run parallel or perpendicular to building structure whenever possible.

D. All ductwork shall be properly sealed.

E. Coordinate the location, provide the necessary access and install all devices provided in other specification sections within Division 23. Including but not limited to fire, smoke and/or balancing dampers, access and mounting for control devices, air flow measuring stations, etc. as apply to this project.

F. All ducts passing through partitions or walls shall pass through at a 90 degree angle. The duct shall be sleeved with the space between the sleeve and duct properly sealed with firestopping material under Division 07 - Firestopping. The sleeve shall be permanently affixed to the wall (see Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment for sleeve specifications).

G. Coordinate the proper duct pressure classification with the systems served and to construct the ductwork to withstand these pressures. (See 3.6 Schedules; System Pressure Classification and Duct Material Schedules.)

H. All ducts located outdoors and not of welded construction shall have seams and

transverse joints sealed water tight with duct sealer, arranged to shed water and finished with insulating duct coating as specified in Section 23 33 00 – Air Duct Accessories.

3.2 CLEANING AND PROTECTION

A. During construction, ductwork shall be cleaned of dirt and debris internally section by section as it is installed. At end of each day, ductwork not finally connected to equipment shall be provided with a temporary closure of polyethylene film or other covering material that will prevent entrance of duct, debris or water. Clean exterior surfaces of any material which might cause corrosion or if the duct is to be painted, it shall be cleaned suitable for painting. After substantial completion of the ductwork system, the system shall be operated with filters in place to blow-out any remaining dust from the system. Protect all equipment and property from damage or fouling during this cleaning. All prefilters used during cleaning shall be replaced prior to turning the system over to the Owner.

3.3 DUCT SEALING REQUIREMENTS

A. All ducts shall have SMACNA Seal Class A (all transverse joints, longitudinal seams and duct wall penetrations).

3.4 LEAK TESTING

A. Duct Leakage Report: The Contractor shall make all the supply, return, outside air, and exhaust duct systems (limited to 1,500 cfm and greater) operationally air-tight, with no more than 10% leakage for duct systems rated at 2" w.c. pressure class, and 5% leakage for systems exceeding 2" w.c. pressure class.

1. Refer to specification section 23 05 93 – Testing, Adjusting and Balancing for HVAC for more information.

3.5 INSTALLATION

A. Galvanized Steel Ductwork:

1. Install ductwork as indicated on the drawings. If any conflict occurs notify the Engineer of Record prior to any extensive rerouting.
2. Install ductwork to allow clearance for the installation of duct insulation.
3. Provide duct liner as specified and/or detailed. (See 3.6 Schedule for liner requirements.)

B. Aluminum Ductwork:

1. Connect to equipment served with a solid duct connection.
2. Slope horizontal runs to inlets at a minimum of 1/4" -/10 LFT. If not possible, slope away from the inlet and provide a continuous drain at the first rise. Coordinate the trapping and d rain piping requirements.
3. All joints shall be sealed water tight.
4. Do not use penetrating screws or rivets for hanging. Support duct from welded clips or from flanges.

C. Stainless Steel Ductwork:

1. Connect to equipment served with a solid connection.
2. Slope horizontal runs to inlet at a minimum of 1/4 inch per one (1) linear foot.
3. All joints shall be sealed air and water tight.

D. Duct Liner:

1. Coordinate the proper duct liner thickness with the liner thickness schedule included in Para. 3.6 - Schedules.
2. The liner shall be applied with fire resistant adhesive and weld pin mechanical fasteners on a maximum of 15" centers for velocities less than 1500 FPM and 12" centers for velocities above 1501 FPM. Adhered or clinched pinched type pins not permitted. When installed, fastener heads shall not compress the insulation more than 1/8” based on the nominal insulation thickness.
3. The liner shall be butted and sealed at all joints, seams and exposed edges to ensure continuous thermal resistance, and condensation control. In unconditioned, non-accessible areas such as chases and dry wall ceilings, the lined duct shall also have an additional layer of duct wrap at the joints for a minimum of 6" either side of the joint to assure condensation control.

3.6 SCHEDULES

A. Ductwork shown to be round or oval is to be provided under Section 23 31 00 - Pre-Fabricated Ductwork.

B. System Pressure Classification and Duct Material Schedule for Shop Fabricated Ductwork:

	System	Section	Maximum Pressure	Duct Material
1.	Outside Air Plenum	All	2" neg.	A
2.	Outside Air Duct	All	2" neg.	A
3.	Supply	AHU to terminal	3" pos.	A
4.	Supply	Terminal to Diffuser	2” pos.	A
5.	Return	All AHU Return	2" neg.	A
6.	Gen. Exhaust	Inlet to Unit	2" neg.	A
7.	Air Transfer Duct	All	2" neg.	A

Schedule Legend:

Duct Material

A Galvanized Steel

END OF SECTION 23 31 01

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SECTION 23 33 00 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Duct access doors.

B. Backdraft dampers.

C. Volume dampers.

D. Prefabricated casing panels.

E. Flexible duct connectors.

F. Roof mounted air outlets and inlets.

G. Louver (Exhaust).

H. Louver (Outside Air Intake).

I. Hardware Cloth.

J. Aluminum brick vent

K. Install miscellaneous control devices.

1.3 QUALITY ASSURANCE

A. All products provided for enhancement of Life Safety shall be UL listed and bear the appropriate label stating compliance.

B. All Products to have a Florida Product Approval Number, as required by the Florida Building Code (FAC 9N-3).

C. All products located in the conditioned air stream or located in return air plenums shall conform to the NFPA 90A Flame/Smoke/Fuel Contribution of 25/50/0 and all other applicable requirements of NFPA 90A.

D. Smoke and Smoke/Fire dampers shall be provided with a 60 month from the date of shipment parts only warranty, including freight for all components, including damper operators.

E. Quality Assurance for Louvers:

1. Source Limitations: Obtain louvers and vents through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
2. Welding: Qualify procedures and personnel according to the following:

a. AWS D1.2, "Structural Welding Code--Aluminum."
b. AWS D1.6, "Structural Welding Code - Stainless Steel."

3. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

F. All louvers shall be tested and comply with AMCA 500-L, 540 & 550 and Florida Test Protocols TAS 201, TAS 202 & TAS 203.

1.4 PERFORMANCE REQUIREMENTS FOR LOUVERS

A. Structural Performance: Provide louvers capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act on vertical projection of louvers.

1. Wind Loads: Determine according to the Wind Information located on Drawings, using the appropriate factors and coefficients.

B. Wind-Driven Rain and Air-Performance Ratings: Provide louvers complying with performance requirements indicated, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

C. Thermal Movements: Provide louvers that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.5 SUBMITTALS

A. Submission for acceptance is required. Submit in accordance with Division 01 requirements.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

C. Submittals for Louvers:

1. Product Data: For each type of product indicated.
2. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other Work. Show blade profiles, angles, and spacing.

a. For installed louvers and vents indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Include summary of forces and loads on walls and jambs.

3. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver.

a. Wind-Driven Rain.
b. Air-Performance.

1.6 PROJECT CONDITIONS FOR LOUVERS

A. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating louvers without field measurements. Coordinate construction to ensure that actual opening dimensions

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Duct Access Doors:

1. Air Balance, Inc.
2. Cesco Products
3. Greenheck, Inc.
4. Nailor Industries, Inc.
5. Nystrom
6. Prefco Products, Inc.
7. Ruskin Manufacturing, Co.
8. Safe Air Inc.

B. Backdraft Dampers:

1. Air Balance, Inc.
2. Cesco Products
3. Greenheck, Inc.
4. Nailor Industries, Inc.
5. Prefco Products, Inc.
6. Ruskin Manufacturing, Co.
7. Safe Air Inc./Dowco

C. Volume Dampers:

1. Air Balance, Inc.
2. Arrow United Industries, Inc.
3. Cesco Products
4. Greenheck, Inc.
5. Nailor Industries, Inc.
6. Prefco Products, Inc.
7. Ruskin Manufacturing, Co.
8. Safe Air Inc./ Dowco

D. Prefabricated Casing Panels:

1. IAC
2. Ruskin
3. Semco
4. United Sheetmetal
5. Vibro Acoustics

E. Flexible Duct Connectors:

1. Ductmate Industries, Inc.
2. Duro-Dyne
3. Elgen
4. Ventfabric

F. Roof Mounted Air Outlets and Inlets:

1. Air Balance, Inc.
2. Cesco Products
3. Greenheck, Inc.
4. Leader, Inc.
5. Loren Cook
6. Ruskin Manufacturing Company

G. Louvers (Exhaust)- No Substitutions Accepted:

1. Airolite Company.
2. Arrow United Industries.
3. Construction Specialties, Inc.
4. Greenheck, Inc.
5. Nystrom Building Products.
6. Ruskin Company; Tomkins PLC.
7. United Enertech

H. Louvers (Outside Air Intake) - No Substitutions Accepted:

1. Airolite Company.
2. Arrow United Industries.
3. Construction Specialties, Inc.
4. Greenheck, Inc.
5. Nystrom Building Products.
6. Ruskin Company; Tomkins PLC.
7. United Enertech

I. Hardware Cloth:

1. McNichols Co.
2. Approved Substitution.

J. Aluminum Brick Vent

1. Greenheck, Inc.
2. Construction Specialties, Inc.
3. Ruskin Manufacturing Company
4. Sunvent
5. T.M. Products Company

2.2 FABRICATION

A. Duct Access Doors:

1. Low Pressure Ductwork:
   a. Rating up to 2" wg positive or negative.
   b. Frame: Minimum 22 gauge galvanized steel or aluminum, minimum 5/8"

knock over edge, neoprene gasket between frame and duct and frame and door.

c. Door: Minimum 24 gauge galvanized steel or aluminum, continuous hinge and cam latches or minimum 2 cam latches, double wall construction, fiberglass insulated thickness to match ductwork.

d. Based on Ruskin Manufacturing Co. ADH24.

2. High Pressure Ductwork:

a. Rating: Up to 10" wg positive pressure.

b. Frame: Minimum 16 gauge galvanized steel with "Z" shaped reinforced corners, polyurethane gasket between frame and duct and frame and door.

c. Door: Minimum 16 gauge galvanized steel or aluminum, minimum 2 spring latches, double wall construction, fiberglass insulated with thickness to match ductwork.

d. Based on Ruskin Manufacturing Co. ADHP-3.

B. Backdraft Dampers:

1. Low Pressure Ductwork:

a. Rating: Up to 1" wg positive or negative.

b. Frame: Minimum 16 gauge (.064") galvanized steel or extruded aluminum.

c. Blades: Minimum 16 gauge (.064") galvanized steel or extruded aluminum parallel blade action, brass bearing, non-ferrous or de-iron pivot pins, gasketed blades.

d. Accessories: Counter balance and weights suitable for assisting or retarding as indicated on the drawings.

e. Based on Ruskin Manufacturing, Co. CBD4.

C. Volume Dampers:

1. Provide volume dampers where indicated, in all branch ductwork and construct as follows:

a. Provide single blades to a maximum of 10 inch blade width.

b. Provide inside end synthetic bearings and locking quadrants with wing nuts.

c. Friction locks are not permitted.

d. Break damper blades on both edges for stiffness.

e. Provide multi-blades on dampers 12 inches and larger with inside pins and molded synthetic bearings, and 2 inches wide by 1/8 inch thick structural galvanized channel frame.

f. Provide galvanized connecting bar with molded synthetic bearings on multi-blade dampers.

g. Provide stand off bracket for installation in externally insulated duct.

h. Based on Ruskin Manufacturing, Co. MD35 for rectangular ducts (MDSR25 for round ducts) with velocities up to 1500 feet per minute.

i. Based on Ruskin Manufacturing, Co. CD30AF1 for rectangular ducts (CDR82 for round ducts) with velocities over 1501 feet per minute.

D. Prefabricated Casing Panels:

1. Panel sections shall consist of an outer sheet of 18 gauge and an inner sheet of 22 gauge galvanized steel. Inside panel surfaces shall have 3/32 inch diameter perforations on 3/16 inch centers.

2. Panels shall be completely metal enclosed; shall be minimum (2) (4) inches thick;

and the space between inner and outer surfaces shall be filled with acoustic material which will not settle, shed or dust.

3. Housing shall be factory fabricated and field assembled with joining members serving to provide structural rigidity to 10 inches water pressure differential, either positive or negative. Structure shall be tested and rated for known structural deflection.
4. The joining members shall be fabricated from galvanized sheet steel, minimum 20 gauge, and shall be arranged to provide a pressure tight air seal against 10 inches pressure differential, either positive or negative. Use Sealing Mastic when joining parallel panels, roof to wall panels, joints and corner joints. Housing shall be fabricated to withstand floor and roof loads of 40 pounds per square foot plus any concentrated loads.
5. Assembly shall be secured against the separation forces of air pressure with cadmium plated metal fasteners.
6. The panel shall have minimum airborne sound transmission loss when tested according to ASTM E90-70.

Transmission Loss in DB

Octave Band HZ	63	125	250	500	1K	2K	4K
Loss	30	16	24	35	45	52	58

7. The thermal conductivity of the panel shall not exceed 0.07 Btu/hr-square foot-degrees F.
8. Insulated access doors shall be provided. Doors shall be constructed of 20 gauge galvanized steel, adequately hinged. Doors shall open against the pressure force and be equipped with safety features such as latches operable from both sides of door and wire glass double pane windows not less than 6 inches x 6 inches square. Doors shall seat against neoprene gaskets. Doors shall have Ventfabrics No. 260 "Ventlok" latches.
9. All openings in the casing for ductwork connections shall be cut and framed at the factory by the panel manufacturer. All openings shall be sealed to prevent air leakage and condensation in accordance with the manufacturer's instructions.
10. All joints, corners, etc., in the panels and floor shall be so designed that no direct path for sound or air leakage can occur.
11. The casing manufacturer shall guarantee that the casings, doors and housings shall meet the acoustical, thermal and air pressure performance specified, when installed in accordance with the manufacturer's recommendations and as noted herein.

E. Flexible Duct Connectors (Required on all duct transitions from AHU to ductwork):

1. Indoor Applications:

a. Material: Heavy glass fabric double - Coated with neoprene, Minimum of 30 oz/sy, Resistant to abrasion and damage due to repeated flexing, waterproof and air tight, minimum 26 gauge galvanized steel or .032" aluminum edge a minimum of 2-1/2" wide each side. Coordinate the flex width with the schedule in 3.3 - Schedule.

b. Rating:

(1) Temperature: -10°F to 200°F

(2) Pressure: 10" positive
10" negative

c. Based on Ventfabric and Ventglass

2. Outdoor Applications:

1. Material: Heavy glass fabric double-coated with hypalon minimum of 26 oz/sy resistant to abrasion and damage due to repeated flexing, water proof, airtight and resistant to damage from direct sunlight, minimum 26 gauge galvanized steel or .032" aluminum edge at minimum of 2-1/2" wide each side. Coordinate the flex width with the schedule in 3.3 - Schedule.

2. Rating:

1) Temperature: -10°F to 250°F
2) Pressure: 10" positive
10" negative

c. Based on Ventfabrics Ventlon.

F. Roof Mounted Air Outlets and Inlets:

1. Louver Faced:

a. Construction: Heavy gauge aluminum extruded louvers, heavy gauge aluminum internal construction, insulated aluminum roof, weather shields designed to prevent wind blown rain from entering at base and to prevent condensation falling from roof or blades from entering duct, aluminum wire mesh bird screen, hinged roof.

b. Refer to mechanical and architectural drawings and schedules for any requirements for Miami Dade/Missile Impact equipment. Hood construction shall be of heavy gauge extruded steel with louvers that are tested and rated to meet PA201-94 Large Missile Impact Test with mitered and welded corners. Hoods shall include an insulated steel cover. Hood bases shall have pre-punched mounting holes and hoods shall be fastened to meet all wind loading requirements as specified by the Florida Building Code. If hood bases are not rated for 160 MPH wind loading, provide a detail on the manufacturers recommendations for tie down connections on each corner of the hood for roof tie-down points.

c. These rated louvered air inlets and outlets are required on all buildings denoted as EHPA on the Architectural Drawings. Based on Loren Cook Model PHB6625D – Must be Miami Dade NOA approved and also have a Florida Product Approval Number.

d. Accessories:

1) Roof Curb: Aluminum construction, self flashing, insulated, 18" unit height.
2) Gravity Backdraft Damper: Parallel blade, aluminum or galvanized construction, adjustable closing force,
3) Motor Operated Damper: Parallel or opposed blade, gasketed damper blades, aluminum or galvanized construction, factory mounted 2 position (open-closed) damper motor, electric operated voltage as scheduled.
4) Motor Operated Damper: Parallel or opposed blade, gasketed damper blades, aluminum or galvanized construction, factory supplied linkage and mount suitable for a pneumatic damper operator.

2. Low Profile Hood Type:

   a. Construction: Heavy gauge aluminum construction, hinged hood, all seams continuously welded, hoods sloped for interior condensate drainage and exterior weather drainage, aluminum wire mesh bird and bug screen.
   b. Accessories:

      1) Roof Curb: Aluminum construction, self flashing, insulated, 18" unit height.
      2) Gravity Backdraft Damper: Parallel blade, aluminum or galvanized construction, adjustable closing force,
      3) Motor Operated Damper: Parallel or opposed blade, gasketed damper blades, aluminum or galvanized construction, factory mounted 2 position (open-closed) damper motor, electric operated voltage as scheduled.
      4) Motor Operated Damper: Parallel or opposed blade, gasketed damper blades, aluminum or galvanized construction, factory supplied linkage and mount suitable for a pneumatic damper operator.
      5) Typical to a Loren Cook GI or GR.

J. Louvers (Exhaust):

1. Frame: Heavy gauge extruded aluminum construction, 5” frame depth with .081 nominal wall thickness.
2. Blades: Vertical rain resistant design, heavy gauge extruded 6063-T5 aluminum blades, 0.063” nominal wall thickness, positioned on approximately 1.5” centers.
3. Bird screen: Flattened expandable aluminum removable frame, ¾” x 0.051” thick, inside mount.
4. Construction: Mechanically Fastened.
5. Minimum Rough Opening Size: Minimum size to be 12”x12”, this supersedes any dimension on the drawing less than 12”x12”. No louver shall have a dimension in width or length smaller than 12”.
6. Maximum Single Section Rough Opening Size: 72” wide x 120” high or 120” wide x 72” high
7. Finish: Louvers are to be clear anodized (or as directed by the Architect).
8. Testing & Compliance with: AMCA 500-L, 540, 550 & Florida Test Protocols TAS 201, TAS 202 & TAS 203.
9. Florida Product Approval #19277.1
10. Miami-Dade, FL NOA #15-0415.05 expires 8/6/2020

    Based on Greenheck: EVH501D - Wind-driven rain resistant stationary louver. (Vertical Blade).

K. Louvers (Outside Air Intake):

1. Frame: Heavy gauge extruded aluminum construction, 5” frame depth with .081 nominal wall thickness.
2. Blades: Vertical rain resistant design, heavy gauge extruded 6063-T5 aluminum blades, 0.063” nominal wall thickness, positioned on approximately 1.5” centers.
3. Bird screen: Flattened expandable aluminum removable frame, ¾” x 0.051” thick, inside mount.
4. Construction: Mechanically Fastened.
5. Minimum Rough Opening Size: Minimum size to be 12”x12”, this supersedes any dimension on the drawing less than 12”x12”. No louver shall have a dimension in width or length smaller than 12”.

6. Maximum Single Section Rough Opening Size: 72” wide x 120” high or 120” wide x 72” high
7. Finish: Louvers are to be clear anodized (or as directed by the Architect).
8. Testing & Compliance with: AMCA 500-L, 540, 550 & Florida Test Protocols TAS 201, TAS 202 & TAS 203.
9. Florida Product Approval #19277.1
10. Miami-Dade, FL NOA #15-0415.05 expires 8/6/2020

Based on Greenheck: EVH501D - Wind-driven rain resistant stationary louver. (Vertical Blade).

L. Hardware Cloth: 4 mesh galvanized steel, plain weave with .035 wire.

M. Aluminum Brick Vent:

1. Extruded aluminum, 0.100” minimum wall thickness for frame and blades. Frame depth 4”.
2. 8-1/8”W x 7-3/4”H with 1-1/2 flanged frame and aluminum mesh screen.
3. Finish shall be “Kynar 500” fluropolymer coating having dry thickness of approximately 1.2 mils when baked at 450°F. Color to be selected by Architect.
4. Minimum free area shall be 39% of nominal size.
5. Based on Ruskin Manufacturing, Co. BV100 or Greenheck Model BVF.

2.3 MATERIALS FOR LOUVERS

A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Aluminum Castings: ASTM B 26/B 26M, alloy 319.

D. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. 4 finish.

E. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.
2. Use Phillips flat-head, hex-head or Phillips pan-head screws for exposed fasteners, unless otherwise indicated.

F. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.4 FABRICATION, GENERAL FOR LOUVERS

A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and

mullions, reinforced with splice plates.

1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern.

C. Maintain equal louver blade spacing to produce uniform appearance.

D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

1. Frame Type: As indicated.

E. Include supports, anchorages, and accessories required for complete assembly.

F. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches (1830 mm) o.c., whichever is less.

G. Provide subsills or extended sills made of same material as louvers where indicated or required for drainage to exterior and to prevent water penetrating to interior.

H. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.5 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

1. Screen Location for Fixed Louvers: Interior face.
2. Screening Type: Insect screening, unless otherwise indicated; bird screening where indicated.

B. Secure screens to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches (150 mm) from each corner and at 12 inches (300 mm) o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same kind and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
2. Finish: Same finish as louver frames to which louver screens are attached.
3. Type: Re-wirable frames with a driven spline or insert for securing screen mesh.

D. Louver Screening for Aluminum Louvers:

1. Bird Screening: Aluminum, 3/4-inch square mesh, 0.063-inch (1.6-mm) wire.

2.6 CLOSURE ANGLES AND CLOSURE PLATES FOR LOUVERS

A. Fabricate from minimum 0.074-inch (2 mm) thick stainless steel or aluminum.

B. Provide continuous closure angles and closure plates on inside head, jambs and sill of exterior wall louvers.

C. Secure angles and plates to louver frames with screws, and to masonry or concrete with fasteners as specified.

D. Provide minimum 0.032-inch (0.8 mm) thick stainless steel or aluminum sleeves in cavity walls and elsewhere as shown.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Install all products in strict accordance with the manufacturer's written installation instructions.

B. Coordinate the installation of products provided within other sections of Division 23 including but not limited to control dampers, airflow measuring stations, etc.

3.2 INSTALLATION

A. Duct Access Doors:

1. Coordinate the proper class access door with the system requirements.
2. Duct access doors shall be mounted so as to allow maximum access and/or door swing while also providing easy access from the floor or other personal accessible structures.
3. Duct access doors shall be provided wherever required for proper maintenance of equipment, access to duct mounted control devices, or visual inspection and setting of dampers, etc. All doors, due to the small scale of the drawings, may not be shown, it is the contractor's responsibility to coordinate with all trades concerned to provide the necessary quantity and properly locate all doors.

B. Backdraft Damper:

1. Securely attach backdraft damper to wall with a suitable sleeve and retaining angles and seal all voids between damper and wall.
2. Adjust damper to open or close under the design conditions.

C. Volume Dampers: Install at all branch take-offs.

1. Install a 24” long yellow strip of material to each damper handle for easy visual location. These strips must be in place prior to Substantial acceptance.

D. Prefabricated Casing Panels:

1. Casing shall be constructed as detailed on drawings. All necessary structural steel bracing required but not shown shall be provided.
2. Casing shall be sealed air tight both positive and negative to $\pm$10 in. w.g.
3. Install in accordance with SMACNA duct construction standards for the pressure indicated.
4. Set access doors minimum 6 inches above floor as detailed on drawings. Arrange door swings so that fan static pressure holds door in closed position.
5. In casing sections subject to collection of water, where deep seal traps are shown, coordinate with other trades to be certain that traps are properly located.
6. All openings in casing shall be framed. All pipes shall be sleeved and area between pipe and sleeve sealed.

H. Flexible Duct Connectors:

1. Flexible duct connectors shall not be omitted where air handling units are provided with internally isolated fans and internal isolation.
2. Provide flexible duct connectors immediately adjacent to all in-line or ductwork

connected fans and/or fan equipped units with or without internal vibration isolation.

3. Flexible duct connectors shall be properly selected and installed to ensure against collapsing under negative pressure and unacceptable ballooning under positive pressure. Leakage is not permissible. See width schedule in 3.3 - Schedules.

I. Roof Mounted Air Outlets and Inlets:

1. Install in accordance with manufacturers written installation instructions.
2. Coordinate installation requirements with roofing sub-contractor.

J. Hardware Cloth: Install over all open ended ducts. Provide sheet metal pocket over raw edges and secure with sheet metal screws through the metal edge cover.

K. Aluminum Brick Vent: Receive an unload louvers and deliver to general contractor at jobsite for storage and installation by general contractor.

L. Install Miscellaneous Control Devices:

1. Install dampers furnished under Section 23 09 23 – Instrumentation and Control Devices for HVAC. Provide necessary blank off sections where dampers are installed in factory fabricated mixing box openings.
2. Install air flow measuring stations furnished under Section 23 09 23– Instrumentation and Control Devices for HVAC. Coordinate size and location with proper access before approving release of units for fabrication and shipment.
3. Install duct smoke detectors provided under Division 26.

3.3 INSTALLATION FOR LOUVERS

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work and in accordance with manufacturer’s recommendations to meet requirements of article titled "Performance Requirements".

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather-tight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Install closure angles and closure plates.

E. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

F. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

H. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weather-tight louver joints are required. Comply with Division 07 - Section "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING FOR LOUVERS

A. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

3.5 SCHEDULES

A. Access Door Schedule:

1. Square or Rectangular Duct work: Access Door Mounting

	Surface Max. Dim.	Access Door Size
a.	6"	12" long Removable Section
b.	7" to 8"	6" x 6"
c.	9" to 12"	8" x 8"
d.	13" to 18"	12" x 12"
e.	19" and up	16" x 16"
f.	Special Situations	See Plans

B. Flexible Duct Connector Schedule

1. Indoor and Outdoor Material Width Schedule

	Duct Size (Max. Dim.)	Pressure (Max.)	Width
a.	12" and less	positive	3"
b.	13" and up	positive	6"
c.	12" and less	negative	3"
d.	13" and up	negative	3"

END OF SECTION 23 33 00

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SECTION 23 34 00 - HVAC FANS

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 WORK INCLUDED

A. Centrifugal roof exhaust fans.

1.3 QUALITY ASSURANCE

A. All electrical components shall be UL listed or labeled.

B. All fans shall be AMCA certified.

C. All components in the conditioned air stream shall conform to the NFPA-90A Flame/Smoke/Fire Contribution Rating of 25/50/0.

D. All electrical devices shall conform to NEMA standards.

E. All wiring shall conform to the NEC.

F. Provide Florida Product Approval Numbers for all Products required by the Florida Building Code (FAC 9N-3).

G. Except where special motors are specified or required for the fan duty, all integral horsepower motors to be high efficiency type as specified in Section 23 05 13 – Common Motor Requirements for HVAC Equipment.

H. After installation, the manufacturer's representative of all equipment provided in this section shall certify in writing to the Owner's representative and Engineer of Record that the equipment has been assembled and installed within the guidelines of the manufacturer's written installation instructions and that its performance meets or exceeds the operating characteristics specified and/or scheduled.

I. Starting of Mechanical Systems:

1. Provide material and labor to perform start-up of each respective item of equipment and system prior to beginning of test, adjust and balance procedures.
2. Provide labor to assist the Owner's Representative in acceptance review.
3. Provide point by point system check-out. Submit results in tabulated form by system. Include this data as part of Operation and Maintenance Manuals.
4. Provide information and assistance and cooperate with test, adjust and balance services.
5. Comply strictly with manufacturer's recommended procedures in starting up mechanical systems.
6. Provide such periodic continuing adjustment services as necessary to ensure proper functioning of mechanical systems until acceptance and up to 1 full year after date of Owner acceptance.

1.4 SUBMITTALS

A. Submit dimension drawings, performance and product data for acceptance. Include fan curves with the system design point plotted, and second point showing compliance with 110% of design static pressure as required by paragraph 3.1 B. Also include fan efficiency and horsepower clearly indicated.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

C. Submit in accordance with Division 01 Requirements.

D. Submit construction details and dimensional data including weights.

1.5 WARRANTY

A. Provide a full parts & labor warranty for 12 months from ship date.

B. Provide an extended 24 month warranty from the expiration of the standard warranty to ensure the Owner has a warranty 1+ year(s) from the substantial completion of the project.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Centrifugal Roof Exhaust Fans:

1. Acme Engineering and Manufacturing Corp.
2. Greenheck Fan Corp.
3. Loren Cook Co.
4. Penn Ventilator Co., Inc.

2.2 CONSTRUCTION

A. Centrifugal Roof Exhaust Fans:

1. Direct or adjustable pitch belt drive as scheduled.
2. Direct Drive fans may have an option for ECM motors, denoted with a “VG” in the model number. Provide a potentiometer dial for control.
3. Housing heavy gauge, aluminum, weatherproof.
4. Wheels centrifugal type.
5. Motor outside of air stream in isolated motor compartment with forced outside air cooling fan motor.
6. Fan and motor on vibration isolation mounts.
7. Motors continuous duty type permanently lubricated bearings factory wired to junction box with disconnect switch.
8. Tip speed and motor horsepower shall not exceed catalog ratings.
9. Accessories to include 18" sound attenuating curb, bird screen, back draft damper and hinged sub-base for damper access.
10. Based on Loren Cook ACEB/ACED-EC or Greenheck GB/G-VG

B. Roof Curbs:

1. The contractor shall coordinate the final curb height with the roofing drawings.
2. The contractor shall ensure a minimum of an 18” curb height, from the top of the finished roof, regardless of insulation thickness.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's installation instructions.

B. Provide fans capable of accommodating static pressure variations of plus 10 percent.

C. Provide matched belts and balanced variable sheaves for motors 15 hp and under, and fixed sheaves for 20 hp and over. Provide belt and sheave changes if required for proper air balancing.

D. Provide belt guards on belt driven fans.

E. Provide safety screen where inlet or outlet is exposed.

F. Provide flexible connections on inlet and outlet of fans connected to ductwork as specified in Section 23 33 00 – Air Duct Accessories.

END OF SECTION 23 34 00

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SECTION 23 36 00 - AIR TERMINAL UNITS – VARIABLE VOLUME

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 WORK INCLUDED

A. Single duct terminal units – Variable volume.

B. Integral heating coils – Electric resistance.

C. Integral terminal unit controls – Direct digital.

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 23 09 23 – Instrumentation and Control Devices for HVAC: Thermostats and control components.

1.4 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. None.

1.5 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

B. UL 181 - Factory-Made Air Ducts and Connectors.

C. NFPA 70 - Electric Duct Heaters.

D. UL 1995, Heating and Cooling Equipment.

E. CUL C22.2 No. 236, Heating and Cooling Equipment.

F. AHRI 880 - Air-Conditioning and Refrigeration Institute Standard Rating Conditions for Air Terminals

G. ASTM A 527 (Steel Sheet, Zinc Coated Galvanized).

H. A-A-1419 or F-F-310 Federal specification (filter element, Air conditioning, Viscous-impingement or Dry type, replaceable), Tested per UL 900.

1.6 QUALITY ASSURANCE

A. All units shall be suitable for use in a return air plenum, if necessary.

B. All components within the air stream shall conform to the NFPA 90A Standard for Flame/Smoke/Fire Contribution of 25/50/0.

C. All units shall be the product of a manufacturer regularly engaged in the production of terminal units and all supplied units shall be clearly described by means of published

catalog data from the same manufacturer.

D. All units shall be capable of maintaining their minimum and maximum set points within a maximum of ±5%.

E. Include letter with submittal data stating that unit controls have been completely coordinated with controls contractor.

F. Terminal box manufacturer shall completely coordinate the controls provided on or required by the box with the control package provide under Section 23 09 23 – Instrumentation and Control Devices for HVAC.

I. Starting of Mechanical Systems:

1. Provide material and labor to perform start-up of each respective item of equipment and system prior to beginning of test, adjust and balance procedures.
2. Provide labor to assist the Owner's Representative in acceptance review.
3. Provide point by point system check-out. Submit results in tabulated form by system. Include this data as part of Operation and Maintenance Manuals.
4. Provide information and assistance and cooperate with test, adjust and balance services.
5. Comply strictly with manufacturer's recommended procedures in starting up mechanical systems.
6. Provide such periodic continuing adjustment services as necessary to ensure proper functioning of mechanical systems until acceptance and up to 1 full year after date of Owner acceptance.

J. Sound Power Data: Manufacturers shall submit sound power data for each comparable size terminal box listed. Sound levels at any speed, at any box, shall not exceed the listings below. The data taken as measured at a distance of one foot from any point on the single duct terminal unit. Based on minimum inlet static pressure +0.5" w.g.

	125 Hz	250 Hz	500 Hz	1K	2K	4K
Discharge	73	69	67	64	64	61
Radiated	68	64	57	52	50	44

1.7 SUBMITTALS

A. Submit dimension drawings, performance and product data for acceptance. Include listing of discharge and radiated sound power level for each of second thru sixth octave band for inlet pressures of 1 inch w.g. Include listing of control air requirements, if applicable.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

C. Submit in accordance with Division 01 Requirements.

1.8 QUALIFICATIONS

A. Manufacturer: The company manufacturing the products specified in this section shall have a minimum of ten years experience producing products of this type.

1.9 SYSTEM RESPONSIBILITY

A. The contractor shall be responsible for any and all costs associated with any and all

changes resulting from the use of a supplier other than the listed acceptable manufacturers.

B. The duct system is computer designed for air balance and noise control using the performance data of the listed manufacturer. Substituting another VAV terminal unit manufacturer may require changes in the system design. These changes may include, but are not limited to, changes in ductwork size or layout, fittings, controls, building structure and piping. The installing contractor, upon substituting an approved alternate, must submit a computerized duct design showing system pressure requirements and acoustic data for the complete duct layout.

1.10 WARRANTY

A. Provide a full parts & labor warranty for 12 months from ship date.

B. Provide an extended 24 month warranty from the expiration of the standard warranty to ensure the Owner has a warranty 1+ year(s) from the substantial completion of the project.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. General

1. Manufacturer shall participate in the AHRI Certification program. Unit performance data shall be rated in accordance with AHRI Standard 880. The manufacturer shall display the AHRI Symbol on all units.

2. Single duct terminal units shall be listed by an independent 3rd party agency as an entire assembly. Separate Duct Heater agency listing is acceptable if heater is placed 4 feet downstream of the terminal unit. UL and ETL are approved.

B. Acceptable Manufacturers

1. Environmental Technologies Inc.
2. Titus
3. Trane

2.2 MANUFACTURED UNITS

A. Single duct terminal units.

1. Ceiling mounted primary air control terminal units for connection to a single medium – 1.5-3.0 in. wg. pressure duct of a central air distribution system. Terminals units may be provided with controls and integral heating coils installed and tested.

B. Identify each terminal unit with clearly marked identification label and airflow indicator. Label shall include unit nominal air flow, maximum factory-set air flow, minimum factory-set air flow, and coil type.

2.3 FABRICATION

A. Units shall be completely factory-assembled, manufactured of corrosion protected steel, and fabricated with a minimum of 18-gauge metal on the high pressure (inlet) side of the terminal unit damper and 22-gauge metal on the low pressure (outlet) side and unit

casing.

B. The interior surface of unit casing acoustically and thermally lined with a minimum of 1-inch, 1.0 lb./cu. ft. density fiberglass with a foil facing. The interior foil liner shall isolate the fiberglass insulation from the airstream and allow for cleaning of the terminal unit interior surfaces. Insulation shall meet NFPA-90A and UL 181 requirements and Bacteriological standard ASTM C 665. Insulation shall have a minimum R-Value of 3.8.

C. All cut edges of insulation shall completely enclosed by metal to arrest cut fibers and prevent erosion into the airstream.

D. Assembly: Primary air control damper, airflow sensor, fans, controls and optional heating coil in single cabinet.

E. Rectangular Supply Air Outlet Connections:

1. Rectangular outlet connections for single duct units shall be slip and drive type.

2.4 PRIMARY AIR CONTROL DAMPER ASSEMBLY

A. Locate primary air control damper assembly inside unit casing. Construct the damper assembly from extruded aluminum and/or a minimum 20 gauge galvanized steel components. Maximum damper leak rate shall not exceed 1% of damper nominal CFM at 4 inch wg. differential.

B. Provide damper assembly with integral flow sensor. Flow sensor shall be provided regardless of control type. Flow sensor shall be a multi-point, averaging, ring or cross type. Bar or single point sensing type is not acceptable.

2.5 HEATING COILS

A. Electric Resistance Heating Coil: Coil shall be factory installed and wired and shall be constructed of open-wire type resistance heat elements. Coils shall be provided with primary and secondary over-temperature protection. Coils shall be constructed for single point power connection. Controls shall consist of an integral control box which includes a 24 VAC transformer. Electric heat coil shall be installed by the terminal unit manufacture.

B. Electric heating units shall ship from the factory with heating coils capable of left or right hand control box without field coordination or unit modification that will void the listing agency certification.

C. Tested with the fan terminal in accordance with UL and ETL standards. Meet all NEC requirements. UL Listed.

D. NEMA 1 electrical enclosure with single point connection for heater and fan. Wiring diagram with specific wiring for each unit included with unit.

E. Automatic reset thermal cutouts for each element, nickel chrome heating element, magnetic disconnecting contactor for each step of control, line and control terminal blocks, interlocking, disconnect, main supply fuses, positive pressure air flow switch, 24 V control transformer. Coordinate with DDC control package provided under Section 23 09 23 – Instrumentation and Control Devices for HVAC.

F. Galvanized steel casing with flanged or drive and slip connection.

G. Heating coil integral with terminal unit, and the heating coil shall be internally wired in

such a manner that assures that a balanced electrical load will be provided across all three phases of the load at all times.

H. Capacity: Provide coils in capacities as scheduled on the drawings.

2.6 WIRING

A. Power Switch (for units without electric heat) - Provide single duct terminals with a factory installed and wired switch to disconnect power to the unit controls.

B. Power Line Fuse (for units without electric heat) – Provide single duct terminals with integral power line fusing installed in the control box to prevent overcurrent damage to the unit controls.

C. Control transformer – Provide single duct terminal units with a factory installed and wired 120 VAC (or voltage as shown on schedule) step down transformers to provide 24 VAC control power to the unit.

2.7 DIRECT DIGITAL VAV CONTROLS

A. Multi-point, multi-axis flow ring or cross sensor to be furnished and mounted by terminal unit manufacturer. Single point or flow bar sensors are not acceptable. Flow sensing device shall be capable of maintaining airflow to within +/- 5 percent of rated unit airflow setpoint when installed with 1.5 duct diameters straight duct, of the same size as the primary airflow inlet, upstream from the unit.

2.8 VARIABLE AIR VOLUME (VAV) TERMINAL UNIT CONTROL

A. The VAV terminal units shall be individually controlled by a DDC VAV controller per VAV terminal unit. The DDC VAV controller, damper motor and transducer shall be supplied by the BAS contractor and furnished to the terminal unit supplier for mounting. Terminal unit manufacture shall be responsible for controller / actuator installation cost

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Support terminal box independent of ductwork.

C. Install terminal boxes to provide maximum clearance for electrical and maintenance access. Contractor to coordinate prior to installation.

D. Coordinate the terminal box controls with the building control system contractor to ensure that all miscellaneous accessories required for proper operation are included and that the direct/reverse action normally closed/normally open functions are properly coordinated.

E. If terminal boxes are installed in areas where access to controls thru a lay-in or removable ceiling is not possible, coordinate the locations of access doors thru the ceiling.

F. Be sure minimum and maximum CFM settings agree with the requirements of the terminal unit schedule.

G. Provide rigid metal straight duct equal to four diameters on inlet of all terminals.

H. Provide transitions from duct size to terminal inlet or outlet size as required.

I. Provide flexible duct connection at outlet plus a minimum of 12" and a maximum of 36"of straight flexible duct upstream of rigid duct at inlet.

J. Provide a minimum of 8’ of flexible duct from re-circulating inlet to grille for sound attenuation.

K. If required, provide a duct transition fitting from the branch duct to the terminal unit, prior to the flex connection.

3.2 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design air flow the minimum and maximum air flows sown on the VAV schedule.

END OF SECTION 23 36 00

SECTION 23 37 13 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Grilles

B. Diffusers

1.3 QUALITY ASSURANCE

A. Manufacturer shall certify cataloged performance and ensure correct application of all air outlet types.

B. All components within the conditioned air stream or exposed in active or non-active plenums shall conform to the NFPA 90A standard for Flame/Smoke/Fire Contribution of 25/50/0.

1.4 SUBMITTALS

A. Submit schedule and product data for acceptance. Coordinate submittal by "G" number and include construction details, capacity ratings including air side pressure drops and NC levels.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

C. Refer to Division 01 for submittal requirements.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Grilles:

1. Anemostat.
2. Price Industries
3. Krueger.
4. Metal*Aire Division of Metal Industries, Inc.
5. Nailor
6. Titus.
7. Trox

B. Diffusers:

1. Anemostat.
2. Price Industries
3. Krueger.
4. Metal*Aire Division of Metal Industries, Inc.
5. Nailor

6. Titus.
7. Trox.

2.2 FABRICATION

A. Grilles:

1. Sidewall or Ceiling Mounted Return/Exhaust Grille (G-4):

a. Construction: Heavy gauge welded steel frame and solid steel horizontal aerodynamically curved bars set at 45° fixed deflection. Size as indicated.
b. Baked enamel finish.
c. Based on Metal*Aire Model SRH or Titus Model 350 RL or Price Model #530.

2. Sidewall or Ceiling Mounted Return/Transfer/Exhaust Grille (G-2):

a. Construction: Heavy gauge aluminum border and 1/2" x 1/2" x 1/2" aluminum eggcrate. Concealed hinged core. Border suitable for use in ceiling specified in Contract Documents. Size as indicated.
b. Baked enamel finish.
c. Based on Titus Model 50F or Metal*Aire Model CC5.

3. Sidewall Double Deflection Supply Grille (G-3):

a. Construction: Aluminum frame with aluminum shaped blades having long blades on front. Size as indicated.
b. Baked enamel finish.
c. Based on Titus Model 300FL or Metal*Aire Model H4004 or Price Model # 620.

4. Door Grilles (G-5):

a. Aluminum frame and blades.
b. Sight proof with V-blades for blocking vision and extra strength.
c. Blades in long dimension.
d. Based on Metal*Aire Model DG-DF or Titus Model CT-700L or Price Model #ATG1.

B. Diffusers:

1. Square Ceiling Diffuser (G-1):

a. Construction: Surface or lay-in mounted, 3 cone diffuser. Round collar size as indicated. Aluminum construction only.
b. Baked enamel finish.
c. Based on on Metal*Aire Model 5700 (steel) or 5700-AL (aluminum) or 5700-AS (Aluminized Steel) or Titus Model TMS (steel) or TMS-AA (aluminum) or Price Model #SCD Steel / ASCD Aluminum

PART 3 - EXECUTION

3.1 GENERAL

A. Install all devices in strict accordance with the manufacturer's written installation instructions.

B. Coordinate the proper grille style and frame style with the final approved ceiling construction and install grilles, registers and diffusers in accordance with the requirements of the architectural reflected ceiling plan.

C. Due to the small scale of the drawings the contractor shall assume the responsibility to coordinate the air outlet and inlet locations with the reflected ceiling plans, lighting plans, sections and or details.

D. Any unlined or otherwise exposed parts beyond the grille, register or diffuser face exposed to sight shall be painted black.

E. Coordinate the color requirements for all grilles, registers and diffusers with the Owner's Representative and Architect.

F. Insulate the back pans of all diffusers per the requirements of Specification Section 23 07 00 – HVAC Insulation.

G. Air distribution devices installed in lay-in ceilings shall have a 24”x24” extended panel.

H. Devices installed in sheetrock or other hard ceilings shall be surface mount type.

END OF SECTION 23 37 13

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SECTION 23 41 00 - PARTICULATE AIR FILTRATION

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 WORK INCLUDED

A. Extended Surface, Pleated, Panel Type Pre Filters (MERV 8).

1.3 QUALITY ASSURANCE

A. Filter testing to be in accordance with UL Standard 900.

1.4 SUBMITTALS

A. Submission for acceptance is not required.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Extended Surface, Pleated, Panel Type Pre Filters.

1. Flanders Filters, Inc.
2. Farr.
3. Purolator Products Air Filtration Co.

2.2 FABRICATION

A. Extended Surface, Pleated, Panel Type Pre Filters:

1. Air filtration efficiency shall be MERV 8 when tested in accordance with ASHRAE 52.2.
2. Filter shall have an initial efficiency of 30% and an average efficiency greater than 30% when tested in accordance with ASHRAE 52.1.
3. Initial air filtration resistance @ 500 fpm shall not exceed a maximum of 0.3” water gauge.
4. Air filter shall have 150 grams of dust holding capacity when tested in accordance with ASHRAE 52.1.
5. Provide independent test reports that support the above technical specifications.
6. Media support shall be steel grid (electro-galvanized expanded metal or pickled welded wire), coated with corrosion inhibitor and a minimum 0.020-inch thick. Grid shall have an effective open area of not less than 96% and shall be bonded to the filter media to eliminate flutter and separation.
7. Enclosing frame shall be constructed of a rigid, heavy duty, high wet strength beverage board; frame shall be treated with solid, unbleached sulfate, hard sized for wet strength and natural clay coated for the purpose of printing with non-toxic biodegradable inks. Frame shall identify manufacturer, model and UL Class.
8. Based on AAF 30/30®.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Install filters and filter gauges in strict accordance with manufacturer’s recommendations. Provide separate gauge tap and valving so that pressure drop can be measured individually across pre-filter.

B. Particular attention to prevent air bypass through filter support system.

C. Do not operate fan systems without pre-filters in place.

D. Provide one extra set of pre-filters.

END OF SECTION 23 41 00

SECTION 23 66 00 – AIR COOLED LIQUID CHILLER

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 WORK INCLUDED

A. Section includes design, performance criteria, controls and control connections, chilled water connections, electrical power connections and refrigerants of the chiller package.

1.3 REFERENCES

A. Products shall be designed, rated and certified in accordance with applicable sections of the following Standards and Codes:

1. To comply with the most recent versions of applicable Standards and Codes of AHRI 550 / 590.
2. AHRI 370 - Standard for Sound Rating of Large outdoor Refrigerating and Air-conditioning Equipment.
3. To comply with the most recent versions of applicable Standards and Codes of ASHRAE 15.
4. Units shall meet the efficiency standards of the latest ASHRAE 90.1 Standard.

1.4 QUALITY ASSURANCE

A. UL 1995 -- Standard for Heating and Cooling Equipment.

B. Manufactured facility to be ISO 9001.

C. Factory Functional Test: The chiller shall be pressure tested, evacuated and fully charged with HFC-410A refrigerant and oil. In addition, a factory functional test to verify correct operation by cycling condenser fans, closing compressor contacts and reading data points from temperature and pressure sensors.

D. Chiller manufacturer shall have a factory trained and supported service organization that is within a 50 mile radius of the site.

E. Installer must have five (5) years of experience in installations of HVAC equipment of the sizes/tonnages and types of equipment specified.

F. Starting of Mechanical Systems:

1. Provide material and labor to perform start-up of each respective item of equipment and system prior to beginning of test, adjust and balance procedures.
2. Provide labor to assist the Owner's Representative in acceptance review.
3. Provide point by point system check-out. Submit results in tabulated form by system. Include this data as part of Operation and Maintenance Manuals.
4. Provide information and assistance and cooperate with test, adjust and balance services.
5. Comply strictly with manufacturer's recommended procedures in starting up mechanical systems.

6. Provide such periodic continuing adjustment services as necessary to ensure proper functioning of mechanical systems until acceptance and up to 1 full year after date of final completion.

G. The installing contractor shall provide the Project Manager certification that all chiller locations comply with allowable local noise ordinances. This includes, but not limited to, Orange County Ordinances #97-27 Section 401.7 & Section 15-182.

1.5 SUBMITTALS

A. Submit dimension drawings, performance and product data for acceptance.

B. Submittal shall include certified performance data at specified design conditions; complete dimensional data on the chiller and starter; control and wiring diagrams showing integration with all necessary equipment as designed for this project; schematic diagram showing recommended auxiliary piping as may be required for the motor, oil cooler or purge if required. If the equipment layout, size or pass arrangement is materially different than that shown on the Contract Documents, a complete piping and equipment layout shall be included. The controls are to be integrated with controls furnished and installed by the temperature control manufacturer. It shall be the responsibility of the chiller manufacturer to completely coordinate these controls so as to provide safe and proper operation of the chiller. Projected sound pressure ratings in each octave band shall also be included in the submittal.

C. Submit letter of certification as described in 1.3; QUALITY ASSURANCE.

D. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

E. Operation and maintenance data - Include manufacturer's descriptive literature, installation checklist, start-up instructions and maintenance procedure.

F. The manufacturer shall furnish complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

1.6 DELIVERY, STORAGE AND HANDLING

A. Unit controls shall be capable of withstanding 150°F storage temperatures in the control compartment.

B. Unit shall be stored and handled per unit manufacturer's recommendations.

C. Units shall be delivered to job site fully assembled and charged with refrigerant (unless selected with nitrogen charge) and oil by the manufacturer.

D. During shipment, provide protective covering over vulnerable components. Fit nozzles and open pipe ends with enclosures.

1.7 WARRANTY

A. Provide a full parts & labor warranty for 60 months from ship date.

B. The warranty items include but are not limited to the following:

1. Whole Units Parts Warranty
2. Whole Unit Labor Warranty
3. Pump Parts & Labor Warranty
4. Refrigerant Warranty

C. Provide an extended compressor parts only warranty for a total of 120 months.

D. Provide an extended service warranty on the chillers (Quarterly Inspections/Preventive Maintenance) for 60 months from final completion on all materials and labor.

1.8 MAINTENANCE SERVICES

A. Provide a full chiller maintenance service for 60 months from substantial completion (see warranty above).

B. All inspections and service of units shall be accomplished by factory trained and authorized servicing technicians.

C. OEM shall provide and report quarterly, annual, and bi-annual maintenance in compliance with or better than ASHRAE Standard 180-2008.

D. Include maintenance items as recommended in manufacturer's operating and maintenance data.

E. Submit copy of service call work orders and summary report to the Owner, including description of work performed, operating performance status and noted exceptions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Carrier

B. Daikin

C. Trane (Model CGAM Basis of Design)

2.2 GENERAL UNIT DESCRIPTION

A. Factory assembled, single-piece chassis, air-cooled liquid chiller. Contained within the package shall be all factory wiring, piping, pumps, controls, and refrigerant charge (HFC-410A). Refer to the chilled water schematic for the requirements of all devices and accessories.

B. All chillers must follow the local Utility Company guidelines to ensure chiller efficiencies meet or exceed the qualifying rebate.

2.3 CABINET

A. Frame shall be heavy-gage, with a powder coated paint finish for both aesthetic appeal and to offer more resistance to corrosion.

B. Units shall be constructed of a galvanized steel frame with galvanized steel panels and access doors. Component surfaces shall be finished with a powder-coated paint. The coating or paint system shall withstand a 1000-consecutive-hour salt spay application in accordance with standard ASTMB117.

C. Provide Architectural louvered hail guards for the entire chiller (not just the condenser

coil) manufactured and installed by the chiller manufacturer.

2.4 COMPRESSORS

A. Fully hermetic scroll type compressors with R410A optimized and dedicated scroll profile.

B. Direct drive motor cooled by suction gas with only three major moving parts and a completely enclosed compression chamber which leads to increased efficiency.

C. Each compressor will have crankcase heaters installed and properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles.

2.5 EVAPORATOR

A. The evaporator shall be a high efficiency, brazed plate-to-plate type heat exchanger consisting of parallel plates. Braze plates shall be stainless steel with copper braze material.

B. The evaporator shall be protected with an etched foil heater and insulated with 1-1/2 inch insulation. This combination shall provide freeze protection down to -20F ambient temperatures while the heater is powered. Contractor shall provide separate power to energize heater and protect evaporator while chiller is disconnected.

C. The water side working pressure shall be rated at 150 psig and tested at 1.5 times maximum allowable water side working pressure.

D. The refrigerant side working pressure shall be rated at 460 psig (29.6 bars) and tested at 1.1 maximum allowable refrigerant side working pressure

2.6 CONDENSER

A. The condenser coils shall consist of copper tubes mechanically bonded into plate-type aluminum fins. A subcooling coil shall be an integral part of the main condenser coil.

B. The maximum allowable working pressure of the condenser shall be 650 psig (44.8 bars). The condensers shall be factory proof and leak tested at 715 psig (49.3 bars).

C. Low Sound Fans shall be dynamically and statically balanced, direct drive, corrosion resistant glass fiber reinforced composite blades molded into a low noise fan blade.

D. Low speed fan motors shall be three-phase with permanently lubricated ball bearings and individually protected by circuit breakers.

E. Unit shall be capable of starting and running at outdoor ambient temperatures from 32F to 125F (0C - 52C) for all sizes.

2.7 ENCLOSURES

A. Mount starters in a UL1995 rated panel for outdoor use.

B. The starter shall be across-the-line configuration, factory-mounted and fully pre-wired to the compressor motor(s) and control panel.

C. A control power transformer shall be factory-installed and factory-wired to provide unit control power.

D. Control panel shall be dead front construction for enhanced service technician safety.

E. Power line connection type shall be standard with a terminal block.

2.8 PUMPS

A. Chilled fluid circuit shall be rated for 150 psig (1034 kPa) working pressure.

B. Proof of flow switch shall be factory installed the correct number of pipe diameters from any elbow and in the correct orientation. In addition, the flow switch shall be factory wired.

C. A water strainer shall be factory provided and installed with a blow down valve to facilitate periodic cleaning of the strainer to prevent it from becoming clogged.

D. One "primary" plus "one stand-by operation" pump shall be provided.

E. The hydronic assembly shall be factory supplied electrical freeze protection to 0ºF.

F. Water pipe extensions with insulation shall be factory installed from the evaporator to the edge of the unit.

G. Each pump motor shall be installed with a variable frequency drive.

H. Pump insulation shall be removed by latches for ease of access.

I. All motors shall be High-E rated motors.

2.9 BUFFER TANK

A. A buffer tank shall be factory installed and engineered for continuous flow.

1. Tank construction shall be welded steel and tank shall be powder coated.
2. Tanks shall be fully insulated and designed with freeze protection down to -20°F.
3. The tank shall be rated with a waterside working pressure of 150 psig and tested at 225 psig.
4. Water pipe extensions shall be grooved pipe and factory installed from the evaporator to the edge of the unit.

2.10 REFRIGERATION COMPONENTS

A. Each refrigerant circuit shall include a filter drier, electronic expansion valve with site glass, liquid line service valves and a complete operating charge of both refrigerant HFC-410A and compressor oil.

B. Each refrigerant circuit shall include a discharge line service valve to allow the refrigerant to be isolated in the condenser.

2.11 CONTROLS, SAFETIES AND DIAGNOSTICS

A. The microprocessor-based unit controller shall be factory-installed and factory-tested.

B. The unit display shall provide the following data:

1. Water and air temperatures
2. Refrigerant levels and temperatures
3. Flow switch status
4. Compressor starts and run times

C. The unit controller shall provide chilled water reset based on return water as an energy saving option.

D. The unit shall shut down if one or more of the following safeties have been breached:

1. Low evaporator refrigerant temperature and/or pressure
2. High condenser refrigerant pressure
3. Low oil flow
4. Motor current overload
5. High compressor discharge temperature
6. Electronic distribution faults: phase loss, phase imbalance, or phase reversal

E. Unit shall be shipped with factory control and power wiring installed.

F. Chilled Fluid Circuit -- with optional integrated evaporator water pump

G. Chilled fluid circuit shall be rated for 150 psig (1034 kPa) working pressure.

H. Proof of flow switch shall be factory installed the correct number of pipe diameters from any elbow and in the correct orientation. In addition, the flow switch shall be factory wired.

I. A water strainer shall be factory provided and installed with a blowdown valve to facilitate periodic cleaning of the strainer to prevent it from becoming clogged.

J. Building Control System Interface:

1. The chiller manufacturer shall provide a communication interface that shall permit complete exchange of chiller data with any BAS system specified in Section 23 09 23 through the use of an BACnet translator. The BACnet translator shall allow the BAS system to issue commands to the chiller to control its operation, change set points, and report all data to the BAS system that is normally available to an integrated control system.
2. The microcomputer control center shall also have the following points hardwired in conjunction with the BACnet Points:

a. Remote chiller start/stop.
b. Reset of chilled water temperature.
c. Reset of current limit.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Install in strict accordance with manufacturers written installation instructions.

3.2 MANUFACTURER'S FIELD SERVICES

A. OEM Startup is performed by factory trained and authorized servicing technicians confirming equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty.

B. Startup reports shall be provided to the Engineer of Record and turned over to the Owner within 24 hours after startup of the chillers.

C. Included OEM Factory Startup:

1. Scroll Chillers
2. Applied Chiller manufacturers shall maintain service capabilities no more than 50 miles from the jobsite.

END OF SECTION 23 66 00

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SECTION 23 73 00 - PACKAGED AIR HANDLING UNITS

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 WORK INCLUDED

A. Packaged Air Handling Units.

1.3 QUALITY ASSURANCE

A. All electrical components shall be listed and labeled by U.L., ETL or a Nationally Recognized Testing Laboratory (NRTL), listed and labeled.

B. Unit performance shall be certified in accordance with ARI Standard 430 for central station air handling units.

C. Coil performance shall be certified in accordance with ARI Standard 410.

D. All components in the conditioned air stream shall conform to the NFPA-90A Flame/Smoke/Fire Contribution Rating of 25/50/0.

E. All electrical devices shall conform to NEMA standards.

F. All wiring shall conform to the NEC.

G. When connected to a 277/480 VAC system, the heating coil shall be listed and labeled at 277 VAC or 480 VAC for single phase or three phase units respectively, regardless of the voltage scheduled on the drawings.

H. Direct expansion coils shall be designed and tested in accordance with ANSI/ASHRAE Standard 15 Safety Code for Mechanical Refrigeration.

I. After installation the manufacturer's representative of all equipment provided in this section shall certify in writing to the Owner's Representative and Engineer of Record that the equipment has been assembled and installed within the guide lines of the manufacturer's written installation instructions and that its performance meets or exceeds the operating characteristics, specified and/or scheduled.

J. In accepting this Contract, the air handling unit manufacturer shall guarantee their units to give capacities not less than the capacities specified with the conditions as specified, without the unit sweating in an unconditioned mechanical room, (it is understood that minor misting of the unit surface may occur at unit seams where thermal breaks do not exist. The manufacturer guarantees that they will take whatever steps are necessary to meet the guarantee, at no additional cost to the Owner, regardless of the extent of the revisions required. A Corporate Officer of the manufacturer shall certify the guarantee and the submittal data.

K. Starting of Mechanical Systems:

1. Provide material and labor to perform start-up of each respective item of equipment and system prior to beginning of test, adjust and balance procedures.

2. Provide labor to assist the Owner's Representative in acceptance review.
3. Provide point by point system check-out. Submit results in tabulated form by system. Include this data as part of Operation and Maintenance Manuals.
4. Provide information and assistance and cooperate with test, adjust and balance services.
5. Comply strictly with manufacturer's recommended procedures in starting up mechanical systems.
6. Provide such periodic continuing adjustment services as necessary to ensure proper functioning of mechanical systems until acceptance and up to 1 full year after date of Owner acceptance.

1.4 SUBMITTALS

A. Submit in accordance with Division 01 requirements.

B. No equipment shall be fabricated or delivered until the receipt of approved shop drawings from the Engineer of Record.

C. AHU manufacturer shall provide the following information with each shop drawing/product data submission:

1. Dimensioned arrangement drawings for each AHU including a plan and elevation view of the assembled unit with overall dimensions, lift points, unit shipping split locations and dimensions, installation and operating weights, and installation, operation and service clearances.
2. All electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations.
3. Each component of the unit shall be identified and mechanical specifications shall be provided for unit and accessories describing construction, components, and options.
4. All performance data, including capacities and airside and waterside pressure drops, for components.
5. Fan curves shall be provided for fans with the design operating points indicated and at 15% greater RPM along the system curve with fan efficiency and horsepower clearly indicated. Data shall be corrected to actual operating conditions, temperatures, and altitudes.
6. Submit computer coil selection clearly indicating system design conditions, as well as coil hand connections, electric heating coil data, where applicable.
7. A filter schedule must be provided for each air handling unit supplied by the air handling unit manufacturer. Schedule shall detail unit tag, unit size, corresponding filter section location within the AHU, filter arrangement (e.g. angled/flat), filter depth, filter type (e.g. pleated media), MERV 8 rating, and filter quantity and size.
8. A schedule detailing necessary trap height shall be provided for each air handling unit. Schedule shall detail unit tag, unit size, appropriate trap schematic with recommended trap dimensions, and unit supplied base rail height. Contractor shall be responsible for additional trap height required for trapping and insulation beyond the unit supplied base rail height by adequate housekeeping pad.
9. A coil valve coordination schedule shall be provided for each air handling unit supplied by the air handling unit manufacturer. Schedule shall detail unit tag, coil type and corresponding section location within the AHU, valve style (e.g. global, ball), valve type (e.g. electronic 2-way/3-way), valve position (e.g. normally open/closed), size, flow coefficient (CV), and close-off pressure.
10. An electrical MCA – MOP schedule shall be provided for each electrical circuit to which field-power must be supplied. Schedule to detail unit tag, circuit description, voltage/phase/hertz, Minimum Circuit Ampacity (MCA), and

calculated Maximum Overcurrent Protection (MOP).

11. Sound data shall be provided using ARI 260 test methods. Unit discharge, inlet, and radiated sound power levels in dB shall be provided for 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz.

D. The AHU manufacturer shall list any exceptions to the specification.

1.5 WARRANTY

A. Provide a full parts & labor warranty for 12 months from ship date.

B. Provide an extended 24 month warranty from the expiration of the standard warranty to ensure the Owner has a warranty 1+ year(s) from the substantial completion of the project.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Packaged Air Handling Units:

1. Carrier
2. Daikin Industries
3. Trane

2.2 FABRICATION

A. Packaged Air Handling Units:

1. General:

a. Sizes, types and performance as indicated on unit schedule.
b. Each unit complete with factory furnished components as shown on the plans. Each air handler unit shall be completely factory assembled, or partially assembled, tested and shipped in one piece or in sections for field assembly depending on size. All casings and access doors shall be of double wall construction. All components shall be assembled on a base rail or mounting legs of sufficient height to provide proper condensate drain trapping, provided with the unit, complete with lifting lugs to accept cable in chain hooks.
c. All units shall have decals and tags to indicate caution areas and to aid unit service. Nameplates shall be fixed to the unit.

2. Cabinet, Casing and Frame:

a. Full height, hinged access doors with hinge and lever latching mechanism shall provide access to each cabinet section from both sides. Access doors shall provide gasketing for a positive seal. Doors shall open outward for negative pressure and inward for positive pressure applications, or have a double latching mechanism for safety.
b. Unit shall be insulated with U.L. listed minimum 2" thick waterproof foam insulation. Insulation to have a minimum thermal resistance or “R-Value” of 13.
c. Unit casing (wall/floor/roof panels and doors) shall be able to withstand up to 1.5 times design static pressure, or 8” w.g., whichever is less, and shall not exceed 0.0042” per inch of panel span (L/240).
d. Casing air leakage shall not exceed 1% of design airflow at the specified

casing pressure.

e. Exterior panels of all sections shall be constructed of 18 gauge or heavier galvanized steel. All sections shall include galvanized steel internal liners. Wall thickness shall be 2".

f. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels.

3. Access Doors:

a. Access doors shall be 2” double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels.

b. All doors downstream of cooling coils shall be provided with a thermal break construction of door panel and door frame.

c. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.

d. Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.

e. Handle hardware shall be designed to prevent unintended closure.

f. Access doors shall be hinged and removable without the use of specialized tools to allow.

g. Hinges shall be interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions.

h. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.

i. All doors shall be a minimum 60” high when sufficient height is available, or the maximum height allowed by the unit height.

4. Coil Sections:

a. Coil sections shall be blow thru or draw thru as scheduled or detailed on drawings and incorporate single or multiple coils. Coils shall be guaranteed to have no moisture carry-over.

b. Coil row depth shall match that shown on the air handling unit schedule, except that the minimum row depth shall be that listed, or 8 rows, whichever is less. Maximum fin density shall be 130 fins per foot, regardless of the value scheduled.

c. Water coils shall be of the cartridge type and have threaded connections (direct expansion coil shall have sweat-type connections) located on the same end. Coil headers, distributors and connections shall be completely enclosed in the unit casing. Vent and drain connections shall be provided on all water cooling coils. Coil supports shall be Type 304 stainless steel.

d. Coils shall have non-ferous headers and copper tubes, mechanically bonded to ripple-corrugated aluminum fins. Coils shall have a staggered tube type design. Coils shall have Type 304 stainless steel casing. Coils shall be certified in accordance with Air Conditioning and Refrigeration Institute (ARI) Standard 410-72. Coil performance shall be substantiated by computer generated output data. Coils shall be suitable for glycol solutions.

e. Chilled water coils shall have 1/2" or 5/8" O.D. copper tubes. Coils shall be circuited for minimum pressure drop. Coils shall be tested at 315 pounds air pressure under warm water and be guaranteed for 150 psig working pressures. Coils shall be guaranteed to produce no carryover.

f. All coils shall have a factory installed serpentine temperature sensor mounted on the discharge of the coil. Refer to the specification section 23 09 23 for more information.

5. Electric Heating Coil Section:

a. Electric heating coils shall be of the slip-in or flange type, using wire construction of 80% nickel and 20% chromium supported in ceramic bushings. The heating wire for each step shall be strung along the entire coil face to prevent stratification when operating at less than full capacity.
b. Terminals and nuts shall be constructed of stainless steel and terminal insulators and bracket bushings shall be constructed of ceramic securely stacked in position. Coil terminals shall be machine crimped to coil wires.
c. Casings shall be constructed of not lighter than 22 gauge galvanized steel with galvanized steel supports on 4 inch centers, gusseted and spot welded. A solid cover shall be provided on the terminal box conforming to Paragraph 5.6 of U.L Standard 1096. Three-eights inch thick rigid fiberglass without metal-to-metal contact shall be installed between the coil and terminal box.
d. Coils shall be tested at twice the rated voltage plus 1,000 volts or at 2,000 volts, whichever is greater. The coils shall be tested and certified for the following: ohm readings to verify capacity, voltage, phase and control voltage.
e. Safety features shall include an automatic reset thermal cutout wired in series with the control and the heat limiters wired in series with the power legs. All safety devices shall be serviceable through the terminal box without removal of the heater from the duct.
f. Built-in components shall include an interlocking disconnect switch, contactors, primary fused transformer, single terminal block, pressure type airflow switch and branch circuit fuses per NEC. All components shall be factory wired and mounted either on the heating coil or in a remote cabinet when shown on the drawings. When the interlocking disconnect switch is built in or externally powered, control circuits are indicated, door interlock micro switches shall be installed at the factory. The frame of the heater shall be provided with a ground stud wired to the terminal block for connection to an external grounding conductor.
g. Solid State Control Relay (SCR) to be provided for infinitely variable power output from 0 to 100% in direct proportion to temperature requirements. Heaters in excess of 20 KW shall have a "vernier" control with an SCR relay and electronic step controller with a minimum of three steps of control. The SCR circuit shall have a KW rating larger than each of the other circuits. The SCR circuit shall be arranged to be first on and last off. When the temperature sensor calls for heat, the SCR circuit will begin to modulate from 0 to 100% capacity. When it reaches 100%, it will stay for one to two minutes. A signal is then sent to the electric step controller to bring in a fixed KW step. The SCR shall then fine tune the KW output. The reverse action shall take place on a fall in temperature. The SCR shall stay at zero output for one or two minutes and then a fixed step shall go off.
h. Contactors shall be of the magnetic disconnecting type.
i. Recessed terminals shall be provided where heating coils are installed in internally lined factory fabricated air handling units. Watts density as measured in watts per square inch of wire surface shall not exceed 35 when installed in draw-through units and 25 when installed in blow-through or VAV units.

6. Condensate Pan:

   a. A double wall condensate drain pan consisting of inner 18 gauge 304SS pan, an outer 18 gauge galvanized steel pan and minimum 5/8" thick rigid foam insulation between the two pans.
   b. Pan shall be non-trapping design sloped to the drain connection and guaranteed not to have standing water after shut-down. It shall extend beyond the leaving airside of the cooling coil and extend underneath the coil connections.
   c. The drain pan shall be thermally isolated from the unit casing. A threaded drain connection shall extend through the unit base.
   d. For stacked coils, an intermediate Type 304 stainless steel drain pan extending a minimum of 6" past shall be provided with drop tubes on each end, or a method to transfer condensate to the lower drain pan shall be provided.

7. Supply Air Fan Section (Refer to Drawing Schedule):

   a. Supply fans shall be double width, double inlet centrifugal type. All fans shall be statically and dynamically balanced for quiet operation. Forward curved fan wheel and housing shall be fabricated from painted cold rolled steel or continuous galvanized steel. Backward curved or Airfoil fan wheels shall be fabricated from aluminum, painted steel, or aluminum alloy with fan blades continuously welded to the back plate and end rim and shall operate in a continuous galvanized steel housing. Units shall have solid steel shafts mounted in heavy-duty greasable ball bearings with L10-80,000 hour rated life. Lubrication lines for the fan bearings shall be extended to the drive side of the unit and shall be copper only. The entire fan assembly shall be completely isolated from the unit bulkhead with vibration absorbing fan discharge seal and mounted on 2" deflection spring isolators for all units above 3,000 CFM capacity. For units 3,000 CFM and less, 1" deflection internal or external spring isolators may be provided.
   b. Fans shall be forward curved, backward curved or Airfoil as scheduled.
   c. The units shall be rated for an RPM 15% greater than that required at the point of selection. If necessary, heavier class construction is to be provided.
   d. Fans for blow-thru applications shall incorporate a discharge diffuser.
   e. Fan motors shall be heavy duty, high efficiency, 1800 RPM, open drip-proof type with greasable ball bearings as specified in Section 23 05 13. The motor shall be provided with have a fixed pitch drive rated to provide 1.4 service factory and be mounted on an adjustable base for proper alignment and belt tension adjustment. Variable volume control will be by adjustable frequency drive as specified in Section 23 05 17.
   f. Provide shaft grounding protection on all motors driven by VFDs.

8. Direct Drive Plenum Fans (Refer to Drawing Schedule):

   a. Provide fan type as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans controlled by variable frequency drives shall be statically and dynamically tested for vibration

and alignment at speeds between 25% and 100% of design RPM. If fans are not factory-tested for vibration and alignment, the contractor shall be responsible for cost and labor associated with field balancing and certified vibration performance. Fan wheels shall be keyed to fan shafts to prevent slipping.

b. The fan type shall be provided as required for stable operation and optimum energy efficiency. The fan shall be a single-width, single-inlet, multiblade-type direct-drive plenum fan. Motor bearing life of the direct-drive plenum fan shall be not less than L-10 250,000 hrs. Fans shall be certified as complying with AHRI Standard 430 and AMCA Publication 211 for airflow performance. Fans shall be tested and rated in-accordance with AHRI Standard 260 and certified as complying with AMCA Publication 311 for sound performance.

c. Fan sections containing multiple fans shall be provided as indicated on the schedule and drawings. Each fan shall operate in parallel to each other fan in the array. The HP characteristic of the fans shall be non-overloading. Fan sections containing multiple fans shall be controlled using a common control signal, such as the duct static control signal, to modulate the fan speed.

d. The fan or fans in total shall be selected to deliver the specified airflow quantity at the specified operating total static pressure. Total static pressure shall include scheduled external static pressure, filter pressure drop at “mid-life” condition, unit opening static losses and all other static loses internal to the AHU.

e. Direct-drive fan and motor assemblies shall be internally isolated from the unit casing with 2-inch deflection spring isolators. A direct-drive fan can be rigidly mounted only if the unit has been tested and rated in-accordance with AHRI Standard 260. Unit sound data shall not exceed scheduled values.

f. Fan motors shall be inverter ready pedestal mounted, ODP selected at the operating voltage and efficiency as specified or as scheduled elsewhere. Each fan motor shall be sized so the fan maximum brake horsepower does not exceed motor’s nominal nameplate rating. Motors shall meet or exceed all NEMA Standards Publication MG 1 – 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.

g. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.

a. Direct-driven fan sections shall use 2-pole (3600 rpm), 4-pole (1800 rpm), or 6-pole (1200 rpm) motors, NEMA Design B, with Class B insulation to operate continuously at 104°F (40°C) ambient without tripping of overloads. Multiple fan selections utilizing 8-pole (900 rpm) motors are unacceptable due to motor inefficiency, cost, and replacement lead times.

b. The fan motor wiring shall be factory-wired to a unit-mounted variable frequency drive, motor overload box or external motor junction box within flexible metal conduit of adequate length so that the fan vibration isolation, if applicable, will not be restricted. Electrician wiring internal to unit is unacceptable.

c. Provide a motor overload panel for multi fan units. The overload panel will provide a single unit mounted UL508A listed control panel with all fans in an array pre-wired to it, such that one properly sized VFD may be

field connected with no additional provisions required for protection of the individual motors. The control panel enclosure will be mounted on the exterior of the fan section and will be NEMA type 1 for indoor units and NEMA type 4 for outdoor units. A single power distribution block shall be provided for connection of the field mounted VFD with one conductor per phase. An electronic motor overload protector with lockable manual isolation switch shall be provided for each motor in the array. Each motor in the array shall be independently grounded with a dedicated green conductor. A minimum of one open ground lug per fan plus one shall be provided for field use. Each motor overload protector shall be provided with an auxiliary contact and all auxiliary contacts will be wired in series to a terminal block for generic trip signaling. The panel will be rated for WYE power systems up to 600V.

d. Fans shall be positioned in the air tunnel cross section and with adequate spacing upstream and downstream for servicing and airflow.

e. Fan sections shall have a minimum of one access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components. Expanded metal door guard(s) shall be supplied on the access door(s) to the fan and those downstream access door(s) where unintended access to the plenum fan could occur. Door guard is intended to deter unauthorized entry and incidental contact with rotating components.

f. The fan (s) shall have an airflow measurement system to measure fan airflow directly or to measure differential pressure that can be used to calculate fan airflow. The system shall predict airflow within +/-5 percent total accuracy (device & transmitter) when operating within the stable operating region of the fan curve. On units supplied with multiple fans, one transmitter shall be supplied for each fan in the array. The submitted fan airflow performance and noise levels shall not be affected by the installation of the device. Any device that provides an obstruction to the fan inlet will not be accepted. Piezometer Flow measurement system will be supplied and installed by the fan manufacturer.

g. Provide shaft grounding rings on all motors driven by a VFD. Typically to an AEGIS – SGR model.

9. Filter Section:

a. The filter section shall be capable of accepting 2"- 30% pre-filters. They shall be supplied complete with galvanized steel filter racks as an integral part of the unit.

b. Provide fixed filter block-offs as required to prevent air bypass around filters.

c. Filters shall be accessible from both sides of the unit or as shown on the documents.

d. The filter section shall be provided with filters and filter differential pressure gauge (refer to controls drawings) as specified in Section 23 41 00 - Particulate Air Filtration.

10. Return Air/Outdoor Air Mixing Section:

a. A return air plenum shall provide 100% return air capability. A duct collar shall accept return air ductwork return air connection as detailed on drawings.

11. Factory Plenum Section Casing: Reinforced mill galvanized or primed steel with baked finish, minimum 18 ga. panels, gasketed joints between panels, 1" thick, 3 lbs. density glass fiber insulation with vapor barrier, access doors with safety latch handles. Suitable for 6.0" w.g. positive or 4" w.g. negative static. Field Built Plenums are NOT acceptable.
12. Discharge Air Plenum: A discharge air plenum shall be provided for sound attenuation with outlet velocities as scheduled and will have 1" duct collar for a bottom or front supply air duct connection as detailed.

PART 3 - EXECUTION

3.1 GENERAL

A. Indoor floor mounted units shall be installed on minimum 4" concrete housekeeping pads and/or as tall as required to allow for condensate drainage.

B. Install 2.5” manufacturer base rail to allow for condensate trapping.

C. The Mechanical Contractor shall level all unit sections in accordance with the unit manufacturer’s instructions. The Mechanical Contractor shall provide and install all necessary permanent shim material to ensure individual sections and entire assembled units are level.

D. The Mechanical Contractor shall be responsible to coordinate ALL of his installation requirements with the Construction Manager to ensure that a complete installation for each unit is being provided. Coordination efforts shall include such items as unloading and hoisting requirements, field wiring requirements, field piping requirements, field ductwork requirements, requirements for assembly of field-bolted or -welded joints, and all other installation and assembly requirements.

E. The AHU manufacturer shall provide all screws and gaskets for joining of sections in the field.

F. If equipment is to be stored for a period of time prior to installation, the Mechanical Contractor shall remove all stretch or shrink wrap from units upon receipt to prevent unit corrosion and shall either place the units in a controlled indoor environment or shall cover the units with canvas tarps and place them in a well-drained area. Covering units with plastic tarps shall not be acceptable.

G. Assemble and install in accordance with manufacturers written installation instructions and details on drawings.

H. Coordinate duct, piping and electrical work so as to provide access to unit for maintenance, filter replacement, coil, fan shaft and motor removal with minimum disturbance of piping.

I. Mount units at proper elevation and arrange condensate trap for proper drainage at design pressure differential. Pipe condensate to nearest floor or roof drain.

J. Install air vents and drain valves to permit proper venting and drainage.

K. Prior to unit start-up all controls shall be installed and tested.

L. Prior to initial start-up and for system testing install air filters to protect the unit and ductwork from dirt and debris. After the system has been tested and prior to turning the system over to the Owner, replace the pre-filters with new, clean filters as specified.

M. All joints or assembled seams of the assembled unit shall be caulked or gasketed air tight up to 1.5 times design static pressure, or 8” w.g., whichever is less, and shall not exceed 0.0042” per inch of panel span (L/240).

N. Prior to turning the system over to the Owner, all damages incurred during shipping, storing and installing shall be repaired. These repairs shall be sufficient to bring the equipment back to the quality standards equal to the original manufacturing standards. These repairs shall include but are not limited to repairing painted surfaces, dent removal, combing coil fins, repairing or replacing wet, sagging or torn insulation, etc.

O. Electric Heating Coils:

1. Install heaters so that the access door can swing fully open, without restriction.
2. Provide uniform duct transition into and out of coil for uniform heating.
3. In cases where coil is inserted in internally lined duct, provide the necessary cold ends and flanges to prevent hot spots.
4. Install in proper direction of airflow to ensure that thermal cut-outs are downstream for proper over temperature protection.
5. Coordinate the control stages, etc. with the temperature control contractor.

END OF SECTION 23 73 00

SECTION 23 81 43 – DUCTLESS SPLIT-SYSTEM AIR CONDITIONING UNIT

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 WORK INCLUDED

A. Ductless Split-System Air Conditioning Unit

1.3 QUALITY ASSURANCE

A. Units shall be listed and labeled by U.L., ETL or a Nationally Recognized Testing Laboratory (NRTL).

B. Units shall be ARI certified.

1.4 SUBMITTALS

A. Submit dimension drawings, performance and product data for acceptance. Include wiring diagrams.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

C. Refer to Division 01 requirements for submittal requirements.

1.5 WARRANTY

A. Provide a 12 month parts & labor warranty on the entire air handling unit and condensing unit from installation date and an extended warranty of 2 years for parts from the installation date.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Ductless Split-System Air Conditioning Unit

1. Carrier
2. Daikin
3. EMI
4. Mitsubishi
5. Sanyo
6. Trane

2.2 FABRICATION

A. Ductless Split-System Air Conditioning Unit:

1. Provide a single, dual, or triple zone air-to-air electric heat pump (outdoor unit) in combination with one, two, or three direct expansion fan coil heat pump (indoor unit), as scheduled, fully piped, wired and operational. Heat pump shall be

designed, tested, and fully charged for use with R-410A refrigerant. Heat pump shall be designed certified by UL and ARI. Complete package to have one (1) year limited parts warranty and compressor to have a four (4) year extended parts warranty.

2. Outdoor Section:

   a. Cabinet shall be constructed of commercial grade galvanized steel, primed and painted to manufacturer's standard color. Access doors with neoprene gaskets shall be provided to allow access to coil, fan, motor and controls. Mounting legs shall be provided.
   b. Compressor shall be high efficiency hermetic reciprocating type or scroll type equipped with a crankcase heater, automatically reversible oil pump, internal high pressure protection, and internal vibration isolation. Compressor wiring for three phase motors shall be provided with an automatically re-setable three phase power monitor to protect the compressor from single phase power conditions. Compressor motor shall have both thermal and current sensitive overload protection.
   c. Outdoor coil shall be constructed of copper tubing with mechanically bonded aluminum fins having all joints brazed, factory installed coil refrigerant metering device to be mounted on unit liquid service valve, with device internal components to be removable for cleaning or replacement.
   d. Outdoor fan shall be propeller type, direct driven, balanced statically and dynamically, and arranged for vertical air discharge. Fan shall be weatherproofed and approved for outdoor use. Fan motor shall be factory lubricated and internally protected.
   e. Controls shall be microprocessor type and shall provide compressor short cycle protection and shall prevent compressor restart for a minimum of five minutes after shutdown. Automatic defrost control shall be provided to accomplish defrosting when coil saturated suction temperature indicates freezing temperatures. Defrost sequence shall call for defrosting for periods of not more than ten minutes every ninety minutes. Liquid line low pressure switch, suction line accumulator with positive oil return, pressure relief switch and a loss of pressure indicator shall be provided.
   f. Unit shall be equipped with filter drier, schrader access valves, refrigerant check valves in the refrigerant line, solenoid type reversing four-way valve to provide automatic changeover, and expansion devices with interconnecting tubing to provide proper refrigerant flow control.
   g. Low refrigerant and high refrigerant cut-outs to be arranged in lock out circuit for manual reset. Control wiring terminal board and 24 volt control circuit transformer to be provided. Terminal board shall be designed to match indoor unit terminal board and furnished complete with factory wiring from board to all internal components and accessory thermostat terminals for standardized point-to-point connectors.

3. Indoor Section:

   a. Cabinet shall be constructed of commercial grade galvanized steel, primed and painted to manufacturer's standard color, and insulated with fireproof, permanent, odorless glass fiber material. Access to be all components shall be provided with neoprene gasketed access panel(s).
   b. Indoor coil shall be constructed of copper tubing with mechanically bonded aluminum fins having all joints brazed. Factory installed refrigerant metering device, refrigerant line fittings which permit mechanical connection on the liquid line and female sweat or mechanical

connection on the gas line, and condensate pan with primary and auxiliary drain connections shall be provided.

c. Fan shall be forward curved, centrifugal type, driven by factory lubricated multi-speed fan motor complete with internal overload protection, and resiliently mounted.

d. Unit shall be provided with factory installed electric heater for supplemental heating to mount in discharge air passage. Elements to be of heavy duty nichrome internally delta- connected on three phase. Heater to have line break high limit controls.

e. Provide a unit mounted microprocessor type low voltage thermostat with automatic cooling/heating function to provide compression cycling, provision for automatic fan cycling or for continuous fan operation and system on/off selection.

4. Unit shall be provided with the following accessories: Unit shall have interface control for when more than one indoor unit is served by one outdoor unit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ductless Split-System Air Conditioning Unit:

1. Install in accordance with manufacturer's recommendations.
2. All openings made in walls or the roof the piping/electrical shall be patched and sealed completely, using materials of similar to existing type construction, to the Owner's and Engineer of Record satisfaction.
3. All refrigerant piping shall follow refrigerant piping techniques.
4. Condensate traps shall be minimum 4 inches deep and shall be field installed. Install plug in condensate drain on opposite side of unit from traps. Condensate drain connection shall be not less than 3/4".
5. All wiring shall comply with applicable local and national codes. Final connections shall be made with liquid -tight type electrical conduit for ease in removal.
6. Maintain necessary access space for filter change and normal maintenance. Piping and electrical connections shall be so located as to eliminate any interference with removal and replacement of filter.
7. Maintain space clearances around heat pump per manufacturer's recommendation.
8. Insert installation and maintenance instructions and parts lists in a one inch ring binder marked "OPERATION AND MAINTENANCE INSTRUCTIONS" and furnish to Owner.

END OF SECTION 23 81 43

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SECTION 23 82 16 - COILS

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 WORK INCLUDED

A. Electric heating coils.

1.3 QUALITY ASSURANCE

A. All electric heating coils shall be listed and labeled by U.L., ETL or a Nationally Recognized Testing Laboratory (NRTL) and comply with NFPA 90A and 90B. When connected to a 277/480 VAC system, the heating coil shall be listed and labeled at 277 VAC or 480 VAC for single phase or three phase units respectively, regardless of the voltage scheduled on the drawings.

1.4 SUBMITTALS

A. Submit dimension drawings, performance and product data for approval.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Electric Heating Coils:

1. Indeeco
2. Bell Thermal Unit
3. Brasch
4. Chromolox
5. Dell
6. Environmental Technologies, Inc.

2.2 DESIGN AND CONSTRUCTION

A. Electric Heating Coils:

1. Electric heating coils shall be open coil of the slip-in or flange type, using wire construction of 80% nickel and 20% chromium supported in ceramic bushings. The heating wire for each step shall be strung along the entire coil face to prevent stratification when operating at less than full capacity.
2. Terminals and nuts shall be constructed of stainless steel and terminal insulators and bracket bushings shall be constructed of ceramic securely stacked in position. Coil terminals shall be machine crimped to coil wires.
3. Casings shall be constructed of not lighter than 22 gauge galvanized steel with galvanized steel supports on 4 inch centers, gusseted and spot welded. A solid cover shall be provided on the terminal box conforming to Paragraph 5.6 of U.L Standard 1096. Three-eights inch thick rigid fiberglass without metal-to-metal

contact shall be installed between the coil and terminal box.

4. Coils shall be tested at twice the rated voltage plus 1,000 volts or at 2,000 volts, whichever is greater. The coils shall be tested and certified for the following: ohm readings to verify capacity, voltage, phase and control voltage.
5. Safety features shall include an automatic rest thermal cutout wired in series with the control and the heat limiters wired in series with the power legs. All safety devices shall be serviceable through the terminal box without removal of the heater from the duct.
6. Built-in components shall include an interlocking disconnect switch, contactors, primary fused transformer, single terminal block, pressure type airflow switch and branch circuit fuses per NEC. All components shall be factory wired and mounted either on the heating coil or in a remote cabinet when shown on the drawings. When the interlocking disconnect switch is built in or externally powered, control circuits are indicated, and door interlock micro switches shall be installed at the factory. The frame of the heater shall be provided with a ground stud wired to the terminal block for connection to an external grounding conductor.
7. Contactors shall be of the magnetic disconnecting type.
8. The heating coil shall be internally wired in such a manner that assures that a balanced electrical load will be provided across all three phases of the load at all times.
9. Solid State Control Relay (SCR) to be provided for infinitely variable power output from 0 to 100% in direct proportion to temperature requirements. Heaters in excess of 20 KW shall have a "vernier" control with an SCR relay and electronic step controller with a minimum of three steps of control. The SCR circuit shall have a KW rating larger than each of the other circuits. The SCR circuit shall be arranged to be first on and last off. When the temperature sensor calls for heat, the SCR circuit will begin to modulate from 0 to 100% capacity. When it reaches 100%, it will stay for one to two minutes. A signal is then sent to the electric step controller to bring in a fixed KW step. The SCR shall then fine tune the KW output. The reverse action shall take place on a fall in temperature. The SCR shall stay at zero output for one or two minutes and then a fixed step shall go off.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Protect coils so flanges are not damaged.

B. Install coils in accordance with manufacturer’s recommendations.

3.2 INSTALLATION

A. Electric Heating Coils:

1. Install heaters so that the access door can swing fully open, without restriction.
2. Provide uniform duct transition into and out of coil for uniform heating.
3. In cases where coil is inserted in internally lined duct, provide the necessary cold ends and flanges to prevent hot spots.
4. Install in proper direction of air flow to ensure that thermal cut-outs are downstream for proper over temperature protection.
5. Coordinate the control stages, etc. with the temperature control contractor.

END OF SECTION 23 82 16

Division 26

Electrical

SECTION 26 01 00 - OPERATION AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and other Division 01, 26, 27, 28 Specification Sections apply to work of this Section.

B. Refer to Division 01 General Requirements Sections: Submittal Procedures, Closeout Procedures and Warranties for additional information regarding preparation of documents..

1.2 SUMMARY

A. O & M Manuals contain operation and maintenance instructions, copies of all warranties and other pertinent information relative to a particular project that is used throughout the life of the facility.

B. This section contains additional requirements for the preparation of Electrical (Power and Lighting) and Systems Operation and Maintenance Manuals.

1.3 OPERATION AND MAINTENANCE MANUALS

A. O & M Data:

1. Manufacturers’ operation and maintenance data is required for all items as called for in the specifications. O & M Manuals shall include manufacturer's name, model number(s), characteristics, manufacturer's agent, service agent, supplier, where and/or what item(s) are used for and description (i.e., surge suppression - switchboard MDPA).

2. Include troubleshooting instructions, list of special tools required, theory of operation, manufacturer's care and cleaning, preventative maintenance instructions, wiring diagrams, and point-to-point schematics.

B. O & M Manuals shall include, but are not limited to:

1. Exhibits:

a) Exhibit B: O & M Manual Cover(s) <Electrical> <Systems>
b) Exhibit D: Spare Parts/Maintenance Stock/Key Certification
c) Exhibit E: Performance Verification and Demonstration to Owner
d) Exhibit F: Specification Section Information Sheet
e) Exhibit G Maintenance Receipt for Project Turnover
f) Conductor Insulation Resistance Test Memo
g) Ground Test Information
h) Voltage and Amperage Readings (Tabulated Data)

2. Shop Drawings: Shop drawings shall be a copy of the final and accepted shop drawing submitted in accordance with Division 01 requirements.

3. Product Data: Product data and/or catalog sheets shall be a copy of the final and accepted submittal submitted in accordance with Division 01 requirements.

4. Warranties/Guarantees: Provide copies of warranties/guarantees in respective location in O & M manual, (Electrical) (Systems). Original warranties/guarantees are to be incorporated as noted in Division 01 General Requirements.

5. Copies of electrical panel schedules and electrical panel directories included with the corresponding specification section.

6. Wiring diagrams, schematic, etc. inserted in proper order, for:
a) Time clocks.

b) Photocells.
c) Control devices, motor controls.
d) Transformers.
e) Panelboards.
f) Distribution panelboards.
g) Each type of product/equipment in Division 27 and 28 sections of these Specifications

7. Division 26
   a) Section 26 05 19 – Building Wire and Cable
      1. Product data and/or catalog sheets on all products applicable to this project.
   b) Section 26 05 26 – Grounding and Bonding
      1. Product data and/or catalog sheets on all products applicable to this project.
      2. Test results on each ground rod.
      3. Ground Test Information Form
   c) Section 26 05 29 – Hangers and Supports
      1. Product data and/or catalog sheets on all products applicable to this project.
   d) Section 26 05 33 - Conduit
      1. Product data and/or catalog sheets on all products applicable to this project.
   e) Section 26 05 34 – Outlet Boxes
      1. Product data and/or catalog sheets on all products applicable to this project.
   f) Section 26 05 35 – Pull and Junction Boxes
      1. Product data and/or catalog sheets on all products applicable to this project.
   g) Section 26 05 53 – Identification for Electrical Systems
      1. Product data and/or catalog sheets on all products applicable to this project.
      2. Equipment supplier list for each section's equipment.
   h) Section 26 05 73 – Power System Study
      1. Copy of complete Study
   i) Section 26 09 23 – Occupancy Sensors
      1. Product data and/or catalog sheets on all products applicable to this project.
      2. Equipment supplier list for section's equipment.
      3. Wiring diagrams.
      4. Parts list.
      5. Operation and maintenance requirements
   j) Section 26 22 13 - Dry Type Transformers
      1. Product data and/or catalog sheets on equipment applicable to this project.
      2. Equipment supplier list for section’s equipment.
      3. Recommended periodic testing procedures.
      4. Parts list.
      5. Any special manufacturer suggested O & M information.
      6. Installation/removal instructions.
      7. Performance Verification and Demonstration to Owner Form
   k) Section 26 24 13 – Distribution Switchboards
      1. Product data and/or catalog sheets on equipment applicable to this project.
      2. Equipment supplier list for section’s equipment.
      3. Internal wiring diagrams.
      4. Bus diagrams.
      5. Operation and maintenance requirements, instructions, and recommended testing.

6. Parts list.
7. Copy of directory.
8. Voltage and Amperage Readings Tabulated Data Form
9. Performance Verification and Demonstration to Owner Form
10. Overcurrent protective devices; in addition to above provide the following for large circuit breakers:
    (a) Parts list.
    (b) Operation and maintenance requirements.
    (c) Wiring diagrams.
    (d) Testing data.
    (e) Installation/removal instructions.
    (f) Performance Verification and Demonstration to Owner Form

l) Section 26 24 16 - Panelboards
1. Product data and/or catalog sheets on equipment applicable to this project.
2. Equipment supplier list for section’s equipment.
3. Internal wiring diagrams.
4. Bus diagrams.
5. Operation and maintenance requirements, instructions, and recommended testing.
6. Parts list.
7. Copy of directory.
8. Voltage and Amperage Readings Tabulated Data Form
9. Performance Verification and Demonstration to Owner Form

m) Section 26 24 17 – Distribution Panelboards
1. Product data and/or catalog sheets on equipment applicable to this project.
2. Equipment supplier list for section’s equipment.
3. Internal wiring diagrams.
4. Bus diagrams.
5. Operation and maintenance requirements, instructions, and recommended testing.
6. Parts list.
7. Copy of directory.
8. Voltage and Amperage Readings Tabulated Data Form
9. Performance Verification and Demonstration to Owner Form
10. Overcurrent protective devices; in addition to above provide the following for large circuit breakers:
    (a) Parts list.
    (b) Operation and maintenance requirements.
    (c) Wiring diagrams.
    (d) Testing data.
    (e) Installation/removal instructions.
    (f) Performance Verification and Demonstration to Owner Form

n) Section 26 27 13 – Utility Service Entrance
1. Product data and/or catalog sheets on products applicable to this project.
2. Equipment supplier list for section’s equipment.
3. Utility Company prepared drawings.

o) Section 26 27 16 – Cabinets and Enclosures
1. Product data and/or catalog sheets on products applicable to this project.
2. Equipment supplier list for section’s equipment.

p) Section 26 27 26 – Wiring Devices
1. Product data and/or catalog sheets on all products applicable to this project.
2. Equipment supplier list for section's equipment.

3. Ground fault wiring devices; in addition to above provide:
   (a) Wiring diagram.

q) Section 26 28 19 – Enclosed Disconnect Switches
1. Product data and/or catalog sheets on equipment applicable to this project.
2. Equipment supplier list for section’s equipment.

r) Section 26 29 13 – Motor Control
1. Product data and/or catalog sheets on equipment applicable to this project.
2. Equipment supplier list for section’s equipment.
3. Motor Control; in addition to above provide the following:
   (a) Internal wiring diagrams.
   (b) Wiring diagrams.
   (c) Bus diagrams.
   (d) Operation and maintenance requirements, instructions, and recommended testing.
   (e) Parts list.
   (f) Copy of directory.
   (g) Performance Verification and Demonstration to Owner Form

s) Section 26 41 13 – Lightning Protection System
1. Product data and/or catalog sheets on all products applicable to this project.
2. Equipment supplier list for section’s equipment.
3. Shop drawing.
4. Product data on all components.
5. Parts list.
6. Operation and maintenance procedures.
7. Copy of lightning protection system master label.
8. Installer's name, address, etc.

t) Section 26 43 00 – Surge Protective Devices
1. Product data and/or catalog sheets on all equipment applicable to this project.
2. Equipment supplier list for section’s equipment.
3. Parts list.
4. Recommended testing and replacement procedures.

u) Section 26 51 13 – Interior Lighting Fixtures, Lamps and Ballasts
1. Product data and/or catalog sheets on all equipment applicable to this project.
2. Equipment supplier list for section’s equipment.
3. Operation and maintenance requirements/instructions for special light fixtures (these fixtures to be determined by A/E) including:
   (a) installation/removal instructions.
   (b) special re-lamping instructions.
4. Parts list.

v) Section 26 52 13 – Emergency Lighting Equipment
1. Product data and/or catalog sheets on all equipment applicable to this project.
2. Equipment supplier list for section’s equipment.
3. Operation and maintenance requirements/instructions for special light fixtures (these fixtures to be determined by A/E) including:
   (a) installation/removal instructions.
   (b) special re-lamping instructions.
4. Parts list.

w) Section 26 56 00 – Exterior Lighting
1. Product data and/or catalog sheets on all equipment applicable to this project.
2. Equipment supplier list for section’s equipment.
3. Operation and maintenance requirements/instructions for special light fixtures (these fixtures to be determined by A/E) including:
(a) installation/removal instructions.
(b) special re-lamping instructions.
4. Parts list.

x) Section 26 56 68 Exterior Athletic Lighting
1. Product data and/or catalog sheets on all equipment applicable to this project.
2. Equipment supplier list for section’s equipment.
3. Operation and maintenance requirements/instructions for special light fixtures (these fixtures to be determined by A/E) including:
(a) installation/removal instructions.
(b) special re-lamping instructions.
4. Parts list.

8. Division 27
a) Division 27 Sections:
1. Installer’s name, address, phone, etc. for each system.
2. Authorized representative’s name, address, phone, etc. for each system.
3. Equipment suppliers name, address, phone, etc. for system.
4. Product data and/or catalog sheets on equipment applicable to this project.
5. Parts list.
6. Wiring diagrams of panels.
7. Shop drawings as submitted and accepted in submittal process.

9. Division 28
a) Division 28 Sections:
1. Installer’s name, address, phone, etc. for system.
2. Authorized representative’s name, address, phone, etc. for each system.
3. Product data and/or catalog sheets on equipment applicable to this project.
4. Parts list.
5. Wiring diagrams of panels.
6. Shop drawings as submitted and accepted in submittal process.

1.4 PROCESSING SUBMITTALS

A. Refer to Division 01 General Requirements.

1.5 DELAYS

A. Contractor is responsible for delays in job project accruing directly or indirectly from late submissions or resubmissions of shop drawings, or product data.

1.6 RESUBMITTALS

A. The A/E shall be reimbursed cost to review resubmittals subsequent to the second submittal.

PART 2 - PRODUCTS (Not Applicable)
PART 3 - EXECUTION (Not Applicable)

Attached Exhibits:
Exhibit B: O & M Manual Cover(s) <Electrical> <Systems>
Exhibit D: Spare Parts/Maintenance Stock/Key Certification
Exhibit E: Performance Verification and Demonstration to Owner

Exhibit F: Specification Section Information Sheet
Exhibit G: Maintenance Receipt for Project Turnover
Conductor Insulation Resistance Test Memo
Ground Test Information
Voltage and Amperage Readings (Tabulated Data)

EXHIBIT B
O & M MANUAL(S) COVER(s)

JONATHAN “SCOTT” PINE COMMUNITY PARK

PROJECT ADDRESS

OPERATION AND MAINTENANCE MANUAL

<ELECTRICAL>
<SYSTEMS>

DATE

EXHIBIT D
SPARE PARTS/MAINTENANCE STOCK/KEY CERTIFICATION

Original of this form shall be included in the Closeout Documentation Manual. ***Copies*** shall also be included in the O&M Manual.

This form verifies that the parts/stock listed below has been delivered to and received by Maintenance.

Project Name:
_____

Type/Name of Spare Parts/Attic Stock/Keys: _____

_____

Specification Reference:_____ _____

Quantity of Spare Parts/Attic Stock:_____

_____

_____

Signature below by the Contractor and Subcontractor signifies that the spare parts/maintenance stock, required by the Contract Documents, have been delivered to the Owner.

_____
CM/GC Company Name

_____ Date: _____
Authorized Title, Printed Name, and Signature

_____
Subcontractor Company Name

_____ Date: _____
Authorized Title, Printed Name, and Signature

_____
Project Management Company Name

_____ Date: _____
Authorized Title, Printed Name, and Signature

Signature by the Owner acknowledges receipt of the same spare parts/maintenance stock.

_____
(printed department name)

_____ Date: _____
Authorized Title, Printed Name, and Signature

EXHIBIT E
PERFORMANCE VERIFICATION AND DEMONSTRATION TO OWNER

Original of this form shall be included in the Closeout Documentation Manual; C***opies*** shall also be included in the O&M Manual.

This form verifies that the Owner has been given the appropriate instructions, training, and/or demonstration of the proper operation on the system(s) or equipment noted below

Project Name: _____

Specification Division Number & Name:_____

System(s)/Equipment Demonstrated: _____

Along with a complete demonstration of the system/equipment, the following items have been reviewed at the demonstration and shall be included under the appropriate Specification Sections in the O&M Manuals:

1. Written operating instructions.
2. Test data and performance verification information as required by the installer and/or manufacturer.
3. Operation and maintenance information published by manufacturer.
4. Printed warranties by manufacturer of equipment/system.
5. Explanation of warranty/guarantee on the system.
6. Drawings showing “As-Built” conditions.
7. Original attendance/sign-in sheet are attached to this Exhibit.

A demonstration of the system/equipment in operation and of the maintenance procedures has been successfully completed.

CM/GC Company Name

_____ Date: _____
Authorized Title, Printed Name and Signature

_____
Subcontractor Company Name

_____ Date: _____
Authorized Title, Printed Name and Signature

_____
Project Management Company Name

_____ Date: _____
Authorized Title, Printed Name and Signature

_____
(printed department name)

_____
Authorized Title, Printed Name and Signature

EXHIBIT F
SPECIFICATION SECTION INFORMATION SHEET

CM/GC shall fill in the blanks below and insert at beginning of each division in the Operation and Maintenance (O&M) Manuals. Submit one (1) sheet for each major division of work.

Project Name: _____

Specification Division – Number & Name: _____

Subcontractor: _____

Contact: _____ Phone: _____

Permit Number: _____ Date Issued: _____

EXHIBIT G
MAINTENANCE RECEIPT for PROJECT TURNOVER

Original of this form shall be included in the Closeout Documentation Manual; ***Copies*** shall also be included in the O&M Manuals.

Date: _____

This form acknowledges that Maintenance is in possession of complete project information including name, address and telephone number of all major Contractor/CM’s, Sub-Contractors and material suppliers for the Project. Further, all parties agree and understand that the project has been completed in full accordance with the Contract Documents and, that as of the date of Substantial completion stated below, Area Maintenance shall be responsible for its continuing maintenance, care and warranty protection.

Project Name: _____

School/Facility: _____

Date of Substantial Completion: _____

Signature below signifies that Area Maintenance received the above project and became responsible for its continuing care and warranty protection.

_____ Date: _____
Area Maintenance Director (printed name)

_____ Date: _____
Owner’s Authorized Construction Representative
(printed name)

_____ Date: _____
Contractor/CM (printed name)

CONDUCTOR INSULATION RESISTANCE TEST MEMO

PROJECT NAME_____

CONDUCTOR FROM _____ TO

SIZE _____

INSULATION TYPE _____

INSULATION VOLTAGE RATING_____

DATE_____ TIME_____

WEATHER CONDITIONS_____

TEST VOLTAGE (DC)_____

RANGE _____

MEGGER INSTRUMENT/SERIAL NUMBER_____

TESTING METHODOLOGY _____

INSULATION RESISTANCE MEASUREMENT (ACCEPTABLE MEASUREMENT NOT TO BE LESS THAN (1) MEGOHM):

PHASE A TO GROUND _____

PHASE B TO GROUND _____

PHASE C TO GROUND _____

NEUTRAL TO GROUND _____

ISOLATED GROUND TO GROUND _____

_____ Date_____
Contractor’s Representative

_____ Date _____
Owner’s Representative

_____ Date _____
Engineer’s Representative

GROUND TEST INFORMATION

PROJECT NAME _____

GROUND TYPE _____

TEST BY _____

DATE OF TEST _____

GROUND LOCATION _____

GROUND TYPE (Rod, Water pipe, etc.)_____

PRIOR TO CONNECTION TO SYSTEM

GROUND _____ (OHMS)

AFTER CONNECTION TO SYSTEM

GROUND _____ (OHMS)

WEATHER CONDITIONS (Wet/Dry) _____

SOIL CONDITIONS (Wet/Dry) _____

_____ Date _____
Contractor’s Representative

_____ Date _____
Engineer’s Representative

_____ Date _____
Owner’s Representative

VOLTAGE AND AMPERAGE READINGS (TABULATED DATA)

PROJECT NAME _____

SWITCHGEAR/PANELBOARD _____

FULL LOAD AMPERAGE READINGS:
DATE _____
TIME _____

PHASE A _____
B _____
C _____
N _____
GROUND _____

FULL LOAD VOLTAGE READINGS:
DATE _____
TIME _____

PHASE A TO N _____ A TO B

B TO N _____ A TO C

C TO N _____ B TO C

VOLTAGE AT THE END OF THE LONGEST BRANCH _____

TYPE OF LOAD _____

NO LOAD VOLTAGE READINGS:
DATE_____
TIME _____

PHASE A TO N _____ A TO B

B TO N _____ A TO C

C TO N _____ B TO C

_____ Date _____
Engineer’s Representative

_____ Date _____
Owner’s Authorized Representative

_____ Date _____
Contractor’s Representative

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01, Division 26, Division 27 and Division 28 Specification Sections, apply to this Section.

1.2 SUMMARY

A. The work required under this Section shall include all materials, labor and auxiliaries required to install a complete and properly operating electrical system.

B. The Contractor shall furnish, perform, or provide all labor including planning, purchasing, transporting, storing, installing, testing, cutting and patching, trenching, excavating, backfilling, coordination, field verification, equipment (installation and safety), supplies, and materials necessary for the correct installation of complete electrical systems (as described or implied by these specifications and the applicable drawings) in strict accordance with applicable codes, which may not be repeated in these specifications, but are expected to be common knowledge of qualified Bidders.

C. The Division 26 Contract Documents refer to work required in addition to (or above) the minimum requirements of the NEC 2011 Edition and applicable local codes. All work shall comply with all applicable codes as a minimum and with the additional requirements called for in these Contract Documents.

D. Only trained and qualified personnel shall be used by the Contractor to perform work. The Contractor shall not perform work, which violates applicable codes, even if called for in the Contract Documents. The Contractor's Bid shall include work necessary to completely install the electrical systems indicated by the Contract Documents in accordance with applicable codes.

E. Refer to other division sections for additional work requirements.

F. Coordinate and verify power and telephone company service requirements prior to bid. Bid to include all work required for complete and properly operating systems..

G. Connections of all items using electric power shall be included under this division of the specifications, including necessary wire, conduit, circuit protection, disconnects and accessories. Securing of roughing-in drawings and connection information for equipment involved shall also be included under this division. See other divisions for specifications for electrically operated equipment.

H. The Contractor shall provide and install panic hardware on all electrical room doors where the electrical room houses equipment rated 1200 amps or more per NEC 110.26. All electrical room doors shall open in the direction of egress.

1.3 WORK SEQUENCE

A. Install work in stages and/or phases to accommodate Owner's occupancy requirements. Coordinate electrical schedule and operations with Owner and Architect/Engineer.

1.4 CODES, FEES, AND STANDARDS

A. Obtain permits and request inspections from Authority Having Jurisdiction and applicable utility companies.

B. Pay for all required licenses, fees, and inspections.

C. Contact the utility companies to determine if fees, charges or costs are required by the utility company for permanent power and for temporary power, installations and hook-ups. These

fees, charges or costs shall be included in Contractor's bid.

D. Material shall be new and free of defects with UL listing or be listed with an approved, nationally recognized Electrical Testing Agency if and only if UL Listing is not available for material.

1.5 PROJECT/SITE CONDITIONS

A. Install Work in locations shown or described in the Contract Documents, unless prevented by project conditions.

B. The Contractor shall install all equipment so that all code required and manufacturer recommended servicing clearances are maintained. Contractor shall be responsible for the proper arrangement and installation of all equipment within any designated space. Should the Contractor determine that a departure from the Contract Documents is necessary, he shall submit to the A/E, for approval, detailed drawings of his proposed changes with his written reasons for the changes. No changes shall be implemented by the Contractor without the issuance of the required drawings, clarifications, and/or change orders.

C. The Contractor shall verify finish dimensions at the project site in preference to using dimensions noted on Contract Documents.

1.6 CONTRACT DOCUMENTS

A. These specifications and applicable drawings shall be considered supplementary, one to the other and are considered Contract Documents. All workmanship, methods, and/or material described or implied by one and not described or implied by the other shall be furnished, performed, or otherwise provided just as if it had appeared in both sets of documents.

B. Where a discrepancy or conflict is found between these specifications and any applicable drawing, the Contractor shall notify the A/E in written form. In the event that a discrepancy exists between specifications and any applicable drawing, the most stringent requirement shall govern unless the discrepancy conflicts with applicable codes wherein the code shall govern. The most stringent requirement shall be that work, product, etc which is the most expensive and costly to implement.

C. The drawings are diagrammatic and are not intended to include every detail of construction, materials, methods, and equipment. They indicate the result to be achieved by an assemblage of various systems. Coordinate equipment locations with Architectural and Structural drawings. Layout equipment before installation so that all trades may install equipment in spaces available. Coordinate installation in a neat and workmanlike manner.

D. Wiring arrangements for equipment shown on the drawings are intended to be diagrammatic and do not show all required conductors and functional connections. All wiring and appurtenances required for the proper operation of all equipment to be connected shall be provided.

E. Specifications require the Contractor to provide shop drawings which shall indicate the fabrication, assembly, installation, and erection of a particular system's components. Drawings that are part of the Contract Documents shall not be considered a substitute for required shop drawings, field installation drawings, code requirements, or applicable standards.

F. Locations indicated for outlets, switches, and equipment are approximate and shall be verified by instructions in specifications and notes on the drawings. Where instructions or notes are insufficient to locate the item, notify the A/E.

G. The Contractor shall take finish dimensions at the project site in preference to scaling dimensions on the drawings.

H. Where the requirements of another Division, section, or part of these specifications exceed the requirements of this Division those requirements shall govern.

1.7 MATERIALS AND EQUIPMENT

A. Material shall be new (except where specifically noted, shown or specified as "Reused") and/or denoted as existing) and shall be UL listed and bear UL label. Where no UL label listing is available for a particular product, material shall be listed with an approved, nationally recognized Electrical Testing Agency. Where no labeling or listing service is available for certain types of equipment, test data shall be submitted to prove to the Engineer that equipment meets or exceeds available standards.

B. Where Contract Documents list design selection or manufacturer, type, this model shall set the standard of quality and performance required. Where no brand name is specified, the source and quality shall be subject to A/E's review and acceptance. Where Contract Documents list accepted substitutions, these items shall comply with requirements in Division 01.

C. When a product is specified to be in accordance with a trade association or government standard and at the request of A/E the Contractor shall furnish a certificate that the product complies with the referenced standard and supporting test data to substantiate compliance.

D. Where multiple items of the same equipment or materials are required, they shall be the product of a single Manufacturer.

E. Where the Contract Documents require materials and/or equipment installed, pulled, or otherwise worked on, the materials and/or equipment shall be furnished and installed by the Contractor responsible for Division 26 methods and materials unless specifically noted otherwise.

F. Where the contract documents refer to the terms "furnish," "install," or "provide," or any combination of these terms) the materials and/or equipment shall be supplied and delivered to the project including all labor, unloading, unpacking, assembly, erection, anchoring, protecting supplies and materials necessary for the correct installation of complete system unless specifically noted otherwise.

G. Before the Contractor orders equipment, the physical size of specified equipment shall be checked to fit spaces allotted on the drawings, with NEC working clearances provided. Internal access for proposed equipment substitutions shall be provided.

H. Electrical equipment shall be protected from the weather during shipment, storage, and construction per manufacturer's recommendations for storage and protection. Should any apparatus be subjected to possible damage by water, it shall be thoroughly dried and put through a dielectric test, at the expense of the Contractor, to ascertain the suitability of the apparatus, or it shall be replaced without additional cost to the Owner. No additional time will be allowed and the project completion date shall be maintained.

I. Inspect all electrical equipment and materials prior to installation. Damaged equipment and materials shall not be installed or placed in service. Replace or repair and test damaged equipment in compliance with industry standards at no additional cost to the Owner. Equipment required for the test shall be provided by the Contractor.

J. Material and equipment shall be provided complete and shall function up to the specified capacity/function. Should any material and/or equipment as a part or as a whole fail to meet performance requirements, replacements shall be made to bring performance up to specified requirements. Damages to finish by such replacements, alterations, or repairs shall be restored to prior conditions, at no additional cost to the Owner.

K. Where tamperproof screws are specified or required, Phillips head or Allen head devices shall not be accepted. For each type used, provide Owner with three tools. Owner will designate the specific hardware design to correspond with existing devices elsewhere in the building, to limit special tool requirements.

L. Where the Contract Documents denote equipment and/or material to be 'new' and/or 'existing'

and also provide no denotation for other equipment as to it being 'new' and/or 'existing,' this is not to infer that the non-denoted equipment is either new or existing, or opposite of the equipment that is denoted. The use of the terms 'new' or 'existing' is meant to clarify denoted equipment/materials for that item only, and the lack of the terms 'new' or 'existing' in relation to identifiers/notes/denotations on the drawings is not to infer that this non-denoted equipment or materials is new or existing.

1.8 MISCELLANEOUS CIRCUITS REQUIRED

A. Provide 120 volt, 20 amp circuit to post indicator valves (whether shown on drawings or not). Connect to spare 20 amp, 1 pole circuit breaker in nearest 120 volt panel. Re-label circuit breaker accordingly. Provide locking device on breaker. Coordinate location with civil engineer (and drawings/specifications) or fire protection engineer (and drawings/specifications) prior to bid and provide all electrical. Coordinate final location and electrical requirements with valve installer after bid and provide all electrical. Nearest panel to be nearest emergency panel, when building has emergency generator system.

B. Provide 120 volt, 20 amp circuit to fire protection system panel and bell (whether shown on drawings or not). Connect to spare 20 amp, 1 pole circuit breaker in nearest 120 volt panel. Re-label circuit breaker accordingly. Provide locking device on breaker. Coordinate location with civil engineer (and drawings/specifications) or fire protection engineer (and drawings/specifications) prior to bid and provide all electrical. Coordinate final location and electrical requirements with panel installer after bid and provide all electrical. Nearest panel to be nearest emergency panel, when building has emergency generator system.

C. Provide 120 volt, 20 amp circuit to intercom system panel (whether shown on drawings or not). Connect to spare 20 amp, 1 pole circuit breaker in nearest 120 volt panel. Re-label circuit breaker accordingly. Provide locking device on breaker. Coordinate location with intercom system engineer (and drawings/specifications) prior to bid and provide all electrical. Coordinate final location and electrical requirements with panel installer after bid and provide all electrical. Nearest panel to be nearest emergency panel, when building has emergency generator system.

D. Provide 120 volt, 20 amp circuit to all fire alarm panels, remote panels, etc. (whether shown on drawings or not). Connect to spare 20 amp, 1 pole circuit breaker in nearest 120 volt panel. Re-label circuit breaker accordingly. Provide locking device on breaker. Coordinate location with fire alarm system engineer (and drawings/specifications) prior to bid and provide all electrical. Coordinate final location and electrical requirements with panel installer after bid and provide all electrical. Nearest panel to be nearest emergency panel, when building has emergency generator system.

E. Provide 120 volt, 20 amp circuit to fire and smoke dampers (whether shown on drawings or not). Connect to spare 20 amp, 1 pole circuit breaker in nearest 120 volt panel. Re-label circuit breaker accordingly. Provide locking device on breaker. Coordinate location with fire protection engineer (and drawings/specifications) prior to bid and provide all electrical. Coordinate final location and electrical requirements with damper installer after bid and provide all electrical. Nearest panel to be nearest emergency panel, when building ahs emergency generator system.

F. Provide 120 volt, 20 amp circuit to building control panels for HVAC system (whether shown on drawings or not). Connect to spare 20 amp, 1 pole circuit breaker in nearest 120 volt panel. Re-label circuit breaker accordingly. Provide locking device on breaker. Coordinate location with fire protection engineer (and drawings/specifications) prior to bid and provide all electrical. Coordinate final location and electrical requirements with damper installer after bid and provide all electrical

1.9 SUPERVISION OF THE WORK

A. Reference the General Conditions for additional requirements.

B. The Contractor shall provide experienced, qualified, and responsible supervision for work. A

competent foreman shall be in charge of the work in progress at all times. If, in the judgment of the A/E, the foreman is not performing his duties satisfactorily, the Contractor shall immediately replace him upon receipt of a letter of request from the A/E. Once a satisfactory foreman has been assigned to the work, he shall not be withdrawn by the Contractor without the written consent of the A/E.

C. Provide field superintendent who has had a minimum of four years previous successful experience on projects of comparable size and complexity. Superintendent shall be on the site at all times during construction and must have an active Journeyman's Electrical License.

D. Superintendent shall be employed by a Florida Registered Electrical Contractor (ER) or Florida Certified Electrical Contractor (EC).

1.10 COORDINATION

A. Provide all required coordination and supervision where work connects to or is affected by work of others, and comply with all requirements affecting this Division. Work required under other divisions, specifications or drawings to be performed by this Division shall be coordinated with the Contractor and such work performed at no additional cost to Owner including but not limited to electrical work required for:

1. Door Hardware.
2. Roll-up Doors.
3. Fire Shutters.
4. Roll-up Grilles.
5. Mechanical Division of the Specifications.
6. Landscape Architect Drawings.
7. Millwork Design Drawings and Shop Drawings.

B. Contractor shall obtain set of Contract Documents from Owner for all areas of work noted above and include all electrical work in bid whether included in Division 26 Contract Documents or not.

C. Installation studies shall be made to coordinate the electrical work with other trades. Work shall be preplanned. Unresolved conflicts shall be referred to the A/E prior to installation of the equipment.

D. For locations where several elements of electrical or combined mechanical and electrical work must be sequenced and positioned with precision in order to fit into the available space, prepare coordination drawings at 1/4 inch scale showing the actual physical dimension required for the installation to assure proper integration of equipment with building systems and NEC required clearances. Coordination drawings shall be provided for all areas determined by the A/E.

E. Secure accepted shop drawings from all required disciplines and verify final electrical characteristics before roughing power feeds to any equipment. When electrical data on accepted shop drawings differs from that shown or called for in Construction Documents, make adjustments to the wiring, disconnects, and branch circuit protection to match that required for the equipment installed.

F. Damage from interference caused by inadequate coordination shall be corrected at no additional cost to the Owner and the contract time for completion will not be extended..

G. The Contractor shall maintain an up-to-date set of Contract Documents and Specifications of all trades on the project site, including Architectural, Structural, Mechanical, Electrical and, where provided Interior Design Drawings.

H. It is the responsibility of this Contractor to coordinate the exact required location of floor outlets, floor ducts, floor stub-ups, etc. with Owner and Architect (and receive their written approval) prior

to rough-in. Locations indicated in Contract Documents are approximate.

I. The Contract Documents describe specific sizes of switches, breakers, fuses, conduits, conductors, motor starters and other items of wiring equipment. These sizes are based on specific items of power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). The Contractor shall coordinate the requirements of each load with each load's respective circuitry shown and with each load's requirements as noted on its nameplate data and manufacturer's published electrical criteria. The Contractor shall adjust circuit breaker, fuse, conduit, and conductor sizes to meet the actual requirements of the equipment being provided and installed and change from single point to multiple points of connection (or vice versa) to meet equipment requirements. Changes due to these coordination efforts shall be made at no additional cost to the Owner.

1.11 PROVISION FOR OPENINGS

A. Locate openings required for work. Provide sleeves, guards or other accepted methods to allow passage of items installed.

B. Coordinate with roofing Contractor on installation of electrical items which pierce roof. Roof penetrations shall not void warranty. The use of pitch pockets is not acceptable.

C. Where work pierces waterproofing, it shall maintain the integrity of the waterproofing. Coordinate roofing materials which pierce roof for compatibility with membrane or other roof types with Contractor prior to installation.

1.12 CONCRETE PADS

A. Furnish and install reinforced concrete housekeeping pads for transformers, switchgear, motor control centers, and other free-standing equipment. Unless otherwise noted, pads shall be four inches high and shall exceed dimensions of equipment being set on them, including future sections, by six inches each side, except when equipment is flush against a wall where the side against the wall shall be flush with the equipment. Pads shall be reinforced with W1.4 x 1.4 6 x 6 welded wire mesh. Chamfer top edges 1/2 inch. Trowel all surfaces smooth. Provide 3000 psi concrete.

B. Contractor to provide/install concrete pad for exterior pad mount transformers as required by power company.

C. Contractor to provide/install concrete pad for exterior generators as recommended by generator manufacturer and structural engineer (8 inch minimum).

1.13 SURFACE MOUNTED EQUIPMENT

A. Surface mounted fixtures, outlets, cabinets, conduit, panels, etc. shall have finish as directed by Engineer.

1.14 CUTTING AND PATCHING

A. New Construction:

1. Reference Division 01 - General Requirements.

2. Cutting of work in place shall be cut, drilled, patched and refinished by trade responsible for initial installation.

3. The Contractor shall be responsible for backfilling and matching new grades with adjacent undisturbed surface.

1.15 TRENCHING

A. Trench excavation in excess of 5 feet deep shall comply with OSHA Standard 29 C.F.R.s. 1926. 650 Subpart P.

1.16 INSTALLATION

A. Erect equipment to minimize interferences and delays in execution of the work.

B. Take care in erection and installation of equipment and materials to avoid marring finishes or surfaces. Any damage shall be repaired or replaced as determined by the A/E at no additional cost to the Owner.

C. Equipment requiring electrical service shall not be energized or placed in service until A/E is notified and is present or have waived their right to be present in writing. Where equipment to be placed in service involves service or connection from another Contractor or the Owner, the Contractor shall notify the Owner in writing when the equipment will be ready. The Owner shall be notified as far in advance as possible of the date the various items of equipment will be complete.

D. Equipment supports shall be secured and supported from structural members except as field accepted by the A/E in writing.

E. Plywood material shall not be used as a backboard for mounting panel boards, disconnects, motor starters, and dry type transformers. Provide "cast in place" type inserts or install expansion type anchor bolts. Electrical equipment shall not be mounted directly to drywall for support without additional channels as anchors. Channels shall be anchored to the floor and structure above. Panelboards and terminal cabinets shall be provided with structural framing located within drywall partitions.

F. The Contractor shall keep the construction site clean of waste materials and rubbish. Upon completion of the work, the Contractor shall remove from the site all debris, waste, unused materials, equipment., etc.

G. Inserts, pipe sleeves, supports, and anchorage of electrical equipment shall be provided. Where items are to be set or embedded in concrete or masonry, the items shall be furnished and a layout made prior to the setting or embedment thereof, so as to cause no delay.

1.17 AS-BUILT DRAWINGS

A. Mark up as-built drawings each day as components are installed. Different colored pencils shall be used to differentiate each system of electrical work. All items on As-Built Drawings shall be shown in actual location installed. Change the equipment schedules to agree with items actually furnished. Refer to Division 01 Closeout Procedures requirements for documentation required for As-Built Drawings and As-Built Manuals.

B. Prior to request for substantial completion observation, furnish a set of neatly marked prints showing "as-installed" (as-built) condition of all electrical installed under this Division of the specifications. Marked up prints are to reflect all changes in work including change orders, field directives, addenda from bid set of Contract Documents, request for information responses, etc. Marked up set of prints are to show:

1. All raceways 1-1/2 inch and above, exactly as installed.
2. All site raceways exactly as installed.
3. Any combining of circuits (which is only allowed by specific permission) or change in homerun outlet box shall be made on as-builts.
4. Any circuit number changes on plan shall be indicated on as-builts.
5. Any panelboard schedule changes shall be indicated on as-builts.

C. Marked up prints as noted above are to be submitted to A/E for acceptance. Contractor shall review submitted As-Builts with Engineer in the field. Contractor shall verify every aspect for accuracy.

D. After acceptance of marked up prints by A/E with all changes, additions, etc. included on accepted marked up prints, submit prior to request for final payment and/or request for final observation.

E. Where the Contractor has failed to produce representative "as-built" drawings in accordance with requirements specified herein, the Contractor shall reimburse Engineer all costs to produce a set of "as-built" drawings to the Architect/Owner satisfaction.

1.18 "OBSERVATION OF WORK" REPORT

A. Reference the General Conditions.

B. Items noted by A/E or his representative during construction and before final acceptance which do not comply with the Contract Documents will be listed in an Observation of Work report which will be sent to the Contractor for immediate action. The Contractor shall correct all deficiencies in a prompt concise manner. After completion of the outstanding items, provide a written confirmation report for each item. The report shall indicate each item noted, and method of correction. Enter the date on which the item was corrected, and return the signed reports so items can be rechecked. Failure to correct the deficiencies in a prompt concise manner or failure to return the signed reports shall be cause for disallowing request for payments.

C. Items noted after acceptance during one-year guarantee period shall be checked by the Contractor in the same manner as above. The signed reports are to be returned by him when the items have been corrected.

1.19 SYSTEMS WARRANTY

A. Reference the General Conditions and Divison 01 Warranties.

B. The work shall include a one-year warranty. This warranty shall be by the Contractor to the Owner for any defective workmanship or material which has been furnished at no cost to the Owner for a period of one year from the date of substantial completion of System. Warranty shall not include light bulbs in service after one month from date of substantial completion of the System. Explain the provisions of warranty to the Owner at the "Demonstration of Completed System" meeting to be scheduled with the Owner upon project completion.

C. Where items of equipment or materials carry a manufacturer's warranty for any period in excess of twelve months, then the manufacturer's warranty shall apply for that particular piece of equipment or material.

D. Where extended warranties or guaranties are called for, furnish in Operation and Maintenance Manuals.

E. All preventative maintenance and normal service will be performed by the Owner's maintenance personnel after final acceptance of the work which shall not alter the Contractor's warranty.

1.20 WASTE MATERIALS DISPOSAL

A. Contractor shall include in his bid the transport and disposal or recycling of all waste materials generated by this project in accordance with all rules, regulations and guidelines applicable. Contractor shall comply fully with Florida statute 403.7186 regarding mercury containing devices and lamps. Lamps, ballasts and other materials shall be transported and disposed of in accordance with all DEP and EPA guidelines applicable at time of disposal. Contractor shall provide owner with written certification of accepted disposal.

1.21 SUBSTANTIAL COMPLETION

A. The Contractor shall be fully responsible for contacting all applicable parties to schedule required observations of the work by Engineer.

B. Work shall be complete as required by authorities having jurisdiction and the general conditions of the contract prior to request for substantial completion observation. Work must be deemed

substantially complete by A/E to fulfill requirements.

1.22 PROHIBITION OF ASBESTOS AND PCB

A. The use of any process involving asbestos or PCB, and the installation of any product, insulation, compound of material containing or incorporating asbestos or PCB, is prohibited. The requirements of this specification for complete and operating electrical systems shall be met without the use of asbestos or PCB.

B. Prior to the Final Review field visit, the Contractor shall certify in writing that the equipment and materials installed in this Project contain no asbestos or PCB’s. Additionally, all manufacturers shall provide a statement with their submittal that indicates that their product contains no asbestos or PCB’s. This statement shall be signed and dated by a duly authorized agent of the manufacturer.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

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SECTION 26 05 06 - DEMONSTRATION OF COMPLETED ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the requirements for demonstration of completed electrical systems.

1.3 DESCRIPTION

A. Demonstrate to Owner the essential features of the following electrical systems:

1. Electrical Entrance Equipment
   a) Circuit breakers
   b) Fuses and fuseholders
   c) Meters (where applicable)
2. Lighting Fixtures (Includes Relamping and Replacing Lenses)
   a) Exit and safety fixtures
   b) Fixtures, indoor and outdoor
3. Lightning Protection System
   a) Air Terminals securely fastened
   b) Ground/test well locations
   c) Present copy of 3 point testing report
4. Distribution Equipment
   a) Lighting and appliance panelboards
   b) Distribution panels
   c) Switchboard
5. Standby Electrical Equipment
   a) Batteries
   b) Battery chargers
   c) Controls and alarms
6. Wiring Devices
   a) Low-voltage controls
   b) Switches: regular, time

B. Upon completion of testing, each system is to be demonstrated only once.

1.4 TIME

A. The demonstration shall be held upon completion of testing of all systems at a date to be agreed upon in writing by the Owner or his representative.

1.5 ATTENDING PARTIES

A. The demonstration shall be held by this Contractor in the presence of the Owner and the manufacturer's representative.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 DEMONSTRATION

A. Demonstrate the function and location (in the structure) of each system, and indicate its relationship to the riser diagrams and drawings.

B. Demonstrate by "start-stop operation" how to work the controls, how to reset protective devices, how to replace fuses, and what to do in case of emergency.

C. Performance Verification and Demonstration to Owner

1. Submit Check Out Memo form for each item, equipment and system. Copy to be included in each Operation and Maintenance Manual.

2. Refer to Section 01 77 00 Closeout Procedures, Exhibit E, Performance Verification and Demonstration to Owner.

END OF SECTION

CHECK OUT MEMO

Check Out Memo shall be completed and a copy provided to the Owner at the Owner's Performance Verification and Demonstration Meeting. A copy shall also be included in the specification section of each O & M Manual for the equipment checked.

Project Name _____

Type of Equipment Checked _____

Equipment Number _____

Equipment Manufacturer _____

Signature below by the manufacturer's authorized representative signifies that the equipment has been satisfactorily tested and checked out on the job by the manufacturer.

1. The attached Test and Data and Performance Verification information was used to evaluate the equipment installation and operation.
2. The equipment is properly installed, has been tested by the manufacturer's authorized representative, and is operating satisfactorily in accordance with all requirements, except for items noted below.*****
3. Written operating and maintenance information has been presented and reviewed in detail with the Contractor.
4. Sufficient copies of all applicable operating and maintenance information, parts lists, lubrication checklists, and warranties have been furnished to the Contractor for insertion in the Operation and Maintenance Manuals.

CHECKED BY:

_____
MANUFACTURER’S REPRESENTATIVE (print)

_____
ADDRESS

_____
TELEPHONE, FAX, E-MAIL

_____
MANUFACTURER’S REPRESENTATIVE (signature, title)

_____
DATE CHECKED

WITNESSED BY:

_____
CONTRACTOR’S REPRESENTATIVE (signature, title)

***EXCEPTIONS NOTED AT TIME OF CHECK-OUT (USE ADDITIONAL PAGE IF NECESSARY)**

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SECTION 26 05 10 - ELECTRICAL SYMBOLS AND ABBREVIATIONS

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 SYMBOLS

A. In general, the symbols used on the Drawings conform to the Standard Symbols of the Institute of Electrical and Electronic Engineers with, the exception of special systems or agencies as hereinafter noted.
B. Corps of Engineers.
C. Special Symbols as shown in schedules or legends.

1.3 ABBREVIATIONS

A. The following abbreviations or initials are used.

A/C	Air Conditioning
AFD	Adjustable Frequency Drive
ac	Alternating Current
ADD #	Addendum #
A/E	Architect/Engineer (or Engineer when Architect not applicable)
AFF	Above Finished Floor
AFG	Above Finished Grade
AHU	Air Handler Unit
AIC	Amps Interrupting Capacity
AL	Aluminum
ALT	Alternate
AMP	Ampere
ANSI	American National Standards Institute
AWG	American Wire Gauge
@	At
BC	Bare Copper
BIDS	Baggage Information Display System
BLDG	Building
BRKR	Breaker
BTU	British Thermal Unit
BTUH	BTU Per Hour
C.	Conduit
CB	Circuit Breaker
CBM	Certified Ballast Manufacturers
cd	Candela
CFM	Cubic Feet per Minute
CKT	Circuit
CKT BRKR	Circuit Breaker
C/L	Center Line
Clg	Ceiling
Comp	Compressor
Conn	Connection
Cond	Condenser
Cont	Continuous
C.R.I.	Color Rendering Index

C.T.	Current Transformer
CU.	Copper
C.U.	Compressor Condenser Unit
C.W.	Cold Water
D.B.	Direct Burial
D.C.	Direct Current
Disc.	Disconnect
DN.	Down
DPST	Double Pole Single Throw
DWG	Drawing
E.C.	Electrical Contractor (or General Contractor)
ELEV.	Elevator
EMT	Electric Metallic Tubing
Equip.	Equipment
EST	Estimate
FAAP	Fire Alarm Annunciator Panel
FACP	Fire Alarm Control Panel
FARP	Fire Alarm Remote Panel
FATC	Fire Alarm Terminal Cabinet
FCCP	Fire Alarm Command Center Panel
FHC	Fire Hose Cabinet
FIDS	Flight Information Display System
FLA	Full Load Amperes
FT.	Feet
FLR	Floor
F.C.	Footcandles
FVNR	Full Voltage Non-Reversing
GAL.	Gallon
Galv.	Galvanized
GPH	Gallons per Hour
GPM	Gallons per Minute
GFI	Ground Fault Interrupting
GRS	Galvanized Rigid Steel Conduit
GND.	Ground
HTG	Heaters
HT	Height
Hz	Hertz (Cycles)
HPF	High Power Factor
HPS	High Pressure Sodium
HP.	Horsepower
HR.	Hour
H.S.	Heat Strip
IMC	Intermediate Metallic Conduit
Incand.	Incandescent
in.	Inches
J.B.	Junction Box
kVA	KiloVolt Ampere
kW	Kilowatts
kWh	Kilowatt Hour
K	Kelvin
LLD	Lamp Lumen Depreciation
LED	Light Emitting Diode
LIU	Light Interface Unit (Fiber Optic Patch Panel)
LT.	Light

LTG.	Lighting
LTS.	Lights
L.P.F.	Low Power Factor
M.C.B.	Main Circuit Breaker
M.L.O.	Main Lugs Only
Maint.	Maintenance
MH.	Manhole; Metal Halide
MFG.	Manufacturer
max.	Maximum
MCM/KCMIL	Thousand Circular Mils
MPH	Miles Per Hour
MM	Millimeter
Min.	Minimum
MCP	Motor Circuit Protector
MTD	Mounted
N.	Neutral
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
N.P.T.	National Pipe Thread
NF	Non Fused
N.C.	Normally Closed
N.O.	Normally Open
NIC.	Not in Contract
No.	Number
OB	Outlet Box
OD	Outside Diameter
O.L.	Overload
OLS	Overloads
OS&Y	Outside Screw and Yoke (Sprinkler)
%	Percent
ø	Phase
P.	Pole
PL	Compact Fluorescent Lamp
P.T.	Potential Transformer
PSF	Pounds per Square Foot
PSI	Pounds per Square Inch
PB	Pullbox
PNL	Panel
PR	Pair
Pri.	Primary
PTZ	Pan, Tilt, Zoom
PVC	Polyvinyl Chloride
Recept.	Receptacle
RPM	Revolutions per Minute
R.S.	Rapid Start
SCA	Short Circuit Amps
Sec.	Secondary
SHT	Sheet
S/N	Solid Neutral
SPST	Single Pole Single Throw
SF	Square Foot
SW.	Switch
SWBD	Switchboard

Sys.	System
THHN; THWN	Nylon Jacketed Wire
TSP	Twisted Shielded Pair
TTB	Telephone Terminal Board
TTC	Telephone Terminal Cabinet
TV	Television
TVTC	Television Terminal Cabinet
TVEC	Television Equip. Cabinet
TYP	Typical
Temp.	Temperature
UL	Underwriters' Laboratories
UTP	Unshielded Twisted Pair
VFD	Variable Frequency Drive
VHF	Very High Frequency
VHO	Very High Output
V	Volt
VA	Volt Amperes
Vol.	Volume
W	Wire
W.P.	Weatherproof
XFMR	Transformer
Y	Wye
Yd.	Yard
Yr.	Year
3R	Rainproof
4X	Stainless Steel Dustight, Watertight

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 26 05 19 - BUILDING WIRE AND CABLE

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 requirements for provision and installation of building wire and cable.

B. Provide all equipment, labor, material, accessories and mounting hardware to properly install all conductors and cables rated 600 volts and less for a complete and operating system for the following:

1. Building wire and cable.
2. Wiring connectors and connections.
3. Metal-Clad cable, Type MC.

C. Aluminum wiring shall be permitted in a limited capacity per requirements set forth in this specification.

D. All sizes shall be given in American Wire Gauge (AWG) or in thousand circular mils (MCM/kcmil).

1.3 REFERENCES

A. ANSI/NFPA 70 National Electrical Code
B. NEC 330
C. UL 486A-486B

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.5 SUBMITTALS

A. Product Data: Submit catalog cut sheets showing type and UL listing of each type of conductor, connector and termination.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Product data and/or catalog sheets on all products applicable to this project.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years experience.

1.8 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet project conditions.

C. Where wire and cable routing is not shown and destination only is indicated, determine exact routing and lengths required.

1.9 COORDINATION

A. Determine required separation between cable and other work.

B. Determine cable routing to avoid interference with other work.

PART 2 - PRODUCTS

2.1 BUILDING WIRE AND CABLE

A. Description: Single or multi-conductor insulated wire.

B. Conductor: Copper and aluminum.

C. Insulation Voltage Rating: 600 volts.

D. Insulation: ANSI/NFPA 70, Type THHN/THWN and XHHW.

E. Metal Clad Cable: NEMA WC70, Type MC with ground wire.

2.2 ALUMINUM CONDUCTORS

A. Aluminum conductors shall be compact stranded aluminum alloy with XHHW-2 insulation. Alcan Stabiloy AA-8030 Series, 600 volt. UL listed and labeled.

B. Refer to Part 3 Execution for termination of aluminum conductors.

PART 3 - EXECUTION

3.1 GENERAL

A. Install products in accordance with manufacturer’s instructions.

B. Use solid conductor for feeders and branch circuits 10 AWG and smaller (except for control circuits).

C. Use conductor no smaller than #12 AWG for power and lighting circuits.

D. Neatly train and lace wiring inside boxes, equipment, and panelboards.

E. All conductors shall be installed in raceway.

F. Conductor sizes indicated on circuit homeruns or in schedules shall be installed over the entire length of the circuit, unless noted otherwise on the Drawings or in these Specifications.

G. Before installing raceways and pulling wire to any mechanical equipment, verify electrical characteristics with final submittal on equipment to assure proper number and AWG of conductors. (As for multiple speed motors, different motor starter arrangements, etc.).

H. Coordinate all wire sizes with lug sizes on equipment, devices, etc. Provide/install lugs as required to match wire size.

I. Where oversized conductors are called for (due to voltage drop, etc.) provide/install lugs as required to match conductors, or provide/install splice box, and splice to reduce conductor size to match lug size.

J. Where type MC cable is used, install in accordance with the National Electrical Code:

3.2 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that mechanical work likely to damage wire has been completed.

3.3 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.4 WIRING METHODS

A. Use only building wire type THHN/THWN for #10 and #12 and THHN/THWN-2 for #8 and larger) insulation in raceway or cable (ac or MC), unless noted otherwise.

B. Wiring in vicinity of heat producing equipment; use only XHHW insulation in raceway.

C. Conductors installed within fluorescent fixture channels shall be Type THHN or XHHW rated 90 degrees C dry. Conductors for all other light fixtures shall have temperature ratings as required to meet the UL listing of the fixture. In no case shall the temperature rating be less than 90 degrees C. Remove incorrect insulation types in new work.

D. Pre-manufactured cable systems for power distribution are not allowed.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Identify wire and cable under provisions of Section 26 05 53 Identification for Electrical Systems.

B. Identify each conductor with its circuit number or other designation indicated on Drawings.

C. Identify neutrals with its associated circuit number(s).

3.6 FIELD QUALITY CONTROL

A. Install products in accordance with manufacturer’s instructions.

B. Use solid conductor for feeders and branch circuits #10 AWG and smaller (except for control circuits). Stranded conductors should be used for connections to vibrating equipment.

C. Use conductor not smaller than #12 AWG for power and lighting circuits.

D. Neatly train and lace wiring inside boxes, equipment, and panelboards

E. All conductors shall be installed in raceway.

F. Conductor sizes indicated on circuit homeruns or in schedules shall be installed over the entire length of the circuit unless noted otherwise on the drawings or in these specifications.

G. Before installing raceways and pulling wire to any mechanical equipment, verify electrical characteristics with final submittal on equipment to assure proper number and AWG of conductors. (As for multiple speed motors, different motor starter arrangements, etc.).

H. Coordinate all wire sizes with lug sizes on equipment, devices, etc. Provide/install lugs as required to match wire size.

I. Where oversized conductors are called for (due to voltage drop, etc.) provide/install lugs as required to match conductors, or provide/install splice box, and splice to reduce conductor size to match lug size.

J. Where Type MC cable is used, install in accordance with the National Electrical Code.

K. Perform field inspection and testing under provisions of the General Requirements of the Contract Documents and Section 26 08 13 Tests and Performance Verification of Electrical Systems.

L. Inspect wire for physical damage and proper connection.

M. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

N. Verify continuity of each branch circuit conductor.

3.7 VERTICAL RISERS

A. Where required by NEC, provide vertical cable riser supports per Article 300-19 in NFPA 70. These shall be located in accessible pullboxes of adequate size. Provide for adequate structural connection of cable supports to pullbox, which will transfer cable weight to building.

3.8 ADDITIONAL REQUIREMENTS FOR METAL CLAD CABLE

A. Metal clad cable may be used only as specified elsewhere in this document, as specified herein, where permitted by NEC, and if approved by the Local Inspecting Authority Having Jurisdiction.

B. MC Cable, where permitted, shall be used only in interior dry locations

C. Cable serving stud wall partitions shall begin from circuit collector boxes/conduit system directly above first device or equipment served. Extending long runs of cable via framing system to avoid installation of raceway system as intended by these Specifications is prohibited. No single run of MC cable shall exceed 30’ in length.

D. Cable shall not be installed where subject to mechanical injury or exposure to heat.

E. MC Cable or Multi-conductor MC Cable homerun is acceptable under following conditions:

1. The homerun cable will be continuous from origination to area served.
2. The required neutrals shall be in the same raceway.
3. The required grounding conductor will be in the same raceway.
4. The homerun cable will terminate in a 4-11/16 sq. box minimum circuit collector box.
5. Cables will not be bundled.
6. Cables will maintain a 1/2” separation from each other.
7. Homerun cables will be labeled at 30’ intervals with the Panel and circuits in the multi-conductor cable and if it passes through a wall, the label shall be provided on both sides within 2’ of the wall.
8. Cable will be supported by the structure or trapeze system of strut and all-thread.
9. Manufacturers bending radius shall not be exceeded. If multiple MC Cables or Multi-conductor MC Cables are routed down a wall, the cables will be independently supported from the wall with their own support system.
10. When homeruns enter the electrical room, they shall terminate in a gutter prior to entering the electrical panel. Joints, taps or splices are not permissible in the gutter. All cables will be labeled in the gutter.

F. Use of MC cable for other than power and lighting branch circuits is not permitted without special written permission by A/E.

G. Connectors and supporting components shall be UL listed for such use.

H. Cut cable with UL listed tools intended for such use. Ream smooth and free of sharp and abrasive areas. Install bushing between conductors and outer jacket. The use of side cutters, snips, or dikes to cut cable is not acceptable.

I. For branch circuit lighting and power circuits only, maximum #8 gauge permitted. Cable shall not be used for feeder circuits or other type systems (i.e. fire alarm, etc.).

J. Maintain minimum 1/2” separation between each cable and support per NEC 330. The practice of bundling cables is not acceptable.

K. Support cable directly from building superstructure. Support maximum of 1’ from every box, cabinet, etc., secure at intervals not to exceed 5’.

L. Install cable minimum of 1’ from communications cable.

M. The use of standard type AC cable in lieu of MC cable is not permitted .

N. Attachment of MC cable to ceiling system or support wires, is allowed if a dedicated wire is used. Support cable directly to building superstructure. Only a vertical cable drop down to a recessed

lay-in luminaire can be supported to the fixture support wire with approved fasteners. Vertical cable drop attachment may be by means of Ty-Rap cable tie if approved by the Local Inspecting Authority Having Jurisdiction and UL plenum rated within plenum air environments.

O. Attachment of cable to, on, or from mechanical (HVAC) equipment, supports, etc., is not permitted.

P. Install cable parallel and perpendicular to building structure.

Q. Install additional supports as necessary to omit cable sagging.

R. Zigzagging cable through building elements as method of support is not acceptable.

S. Cable with outer metal sheath damaged by construction elements and/or improper installation shall be replaced at no additional cost to Owner.

T. Cable shall be securely fastened with UL listed devices intended for such use.

U. Manufacturers recommended bending radius shall not be exceeded.

V. MC cabling is permissible to be used as a switchleg with the following conditions:

1. No other wiring is permitted in the cable except the power, switchleg and the grounding conductor.

3.9 PULLING

A. No wire shall be pulled until the conduit system is complete from pull point to pull point and major equipment terminating conduits have been fixed in position.

B. Mechanical pulling devices shall not be used on conductors sized #8 and smaller. Pulling means which might damage the raceway shall not be used.

C. Use only powdered soapstone or other pulling lubricant acceptable to the A/E. Compound or lubricant shall not cause the conductor or insulation to deteriorate.

D. All conductors to be installed in a common raceway shall be pulled together. The manufacturer's recommended pulling tensions shall not be exceeded.

E. Bending radius of insulated wire or cable shall not be less than the minimum recommended by the manufacturer.

F. Where communications type conductors are installed, special requirements shall apply as outlined under that specific system detailed specifications.

3.10 CONTROL AND SIGNAL CIRCUITS

A. Free-wire cabling is permissible with the following conditions:

1. All cabling will be supported by J-hooks.

2. All cabling entering a wall shall be sleeved by conduit (not FMC) to the junction box where the device is to be terminated.

3. Bending radius of the cable shall not be less than the minimum recommended by the manufacturer.

4. Only red cabling shall be used for the F/A System.

5. Install cables parallel and perpendicular to the building structure.

6. Install additional supports as necessary to omit cable sagging.

7. Zigzagging cables through building elements as method of support is not acceptable.

8. All rated walls and partition walls shall be sleeved for cable through penetrations.

9. Cable or outer sheath damaged by construction elements and/or improper installation shall be replaced at no additional cost to Owner in its entirety, the cable shall not be spliced or the jacket taped to be repaired.

10. Cables shall be securely fastened with UL listed devices intended for such use.

3.11 COLOR CODING

A. All power feeders and branch circuits No. 6 and smaller shall be wired with color-coded wire with the same color used for a system throughout the building. Power feeders above No. 6 shall either be fully color-coded or shall have black insulation and be similarly color-coded with tape or paint in all junction boxes and panels. Tape or paint shall completely cover the full length of conductor insulation within the box or panel.

B. Unless otherwise accepted or required by A/E to match existing, color-code shall be as follows:
Neutrals: 120/208V system white; 277/480V system natural gray
Ground Wire: green, bare
Isolated Ground Wire: green with yellow stripes
120/208V: Phase A Black, Phase B Red, Phase C Blue
277/480V: Phase A Brown, Phase B Orange, Phase C Yellow

C. All switchlegs, other voltage system wiring, control and interlock wiring shall be color-coded other than those noted above.

3.12 TAPS/SPLICES/CONNECTORS/TERMINATIONS

A. Clean conductor surfaces before installing lugs and connectors.

B. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

C. Power and lighting conductors shall be continuous and unspliced where located within conduit. Splices shall occur within troughs, wireways, outlet boxes, or equipment enclosures where sufficient additional room is provided for all splices. No splices shall be made in in-ground pull boxes (without written acceptance of Engineer).

D. Splices in lighting and power outlet boxes, wireway, and troughs shall be kept to a minimum. Pull conductors through to equipment, terminal cabinets, and devices.

E. No splices shall be made in junction box or outlet boxes (wire No. 8 and larger) without written acceptance of Engineer.

F. No splices shall be made in communications outlet boxes, pull boxes or wireways (i.e., fire alarm, computer, telephone, intercom, sound system, etc.) without written acceptance of Engineer. Pull cable through to equipment cabinets, terminal cabinets and devices.

G. Allow adequate conductor lengths in all junction boxes, pull boxes and terminal cabinets. All termination of conductors in which conductor is in tension will be rejected and shall be replaced with conductors of adequate length. This requirement shall include the Contractor to provide sleeve type vertical cable supports in vertical raceway installations provided in pullboxes at proper vertical spacings.

H. A calibrated torque wrench shall be used for all bolt tightening.

I. Interior Locations:

1. All (non-electronic systems) copper taps and splices in No. 8 or smaller shall be fastened together by means of "spring type" connectors. All taps and splices in wire larger than No. 8 shall be made with compression type connectors and taped to provide insulation equal to wire.

J. Exterior Locations:

1. Make splices, taps and terminations above grade in splice or termination cabinets. Do not splice any cable in ground or below finished grade.
2. All taps and splices shall be made with compression type connectors and covered with Raychem heavywall cable sleeves (type CRSM-CT, WCSM or MCK) with type "S" sealant coating with sleeve kits as per manufacturer's installation instructions or be terminated/connected to terminal strips in above grade terminal boxes suitable for use.
3. Provide and install above grade termination cabinets sized to meet applicable codes and standards, where required for splicing.

3.13 ALUMINUM CONDUCTORS

A. Aluminum conductors #1 AWG or larger shall be used for panelboard feeders and service entrance conductors only.

B. Connections:

1. Wire from load side of all disconnect switches to connect moving, vibrating, heat producing equipment (including indoor transformers), shall be copper with same ampacity as feeder, even if feeder to disconnect switch is specified aluminum. Proper UL accepted lugs must be provided in disconnect switch for type and size of wire used. Where an aluminum feeder connects to equipment that does not require an external disconnect switch, the aluminum wire shall be spliced to copper with UL accepted compression connectors before being connected to the lugs or terminals of the equipment, even though the lugs are accepted for combination copper and aluminum use. No aluminum shall be connected to motors.

C. Terminations, Splices and Taps:

1. Where aluminum conductors, No. 1 AWG and larger are terminated, spliced or tapped, the connectors shall be color-coded, tool applied compression type made of aluminum with wire barrels factory prefilled with oxide inhibiting compound.
2. Connectors must pass UL Standard 486A-486B, bear markings AL7CU (75 degrees C) or AL97C (90 degrees C) for application, and have UL label.
3. Set screw type connectors are not acceptable.
4. Installation shall be as follows:

a) Installing tools and dies, of hexagonal or circumferential type made by the connector manufacturer shall be used for installation. Tooling shall be with color-coded or dieconnector coding system for inspection purposes. Where UL listing is applicable for connectors, the manufacturer's recommended toolings shall be used. Conductors shall be cleaned with a wire brush immediately before connecting.

b) Terminal lugs with bolting pads shall be tinplated for low contact resistance.

c) The connectors shall meet the performance requirement Underwriters Laboratories Test of UL 486A-486B, except that heating or current cycling tests shall be for a minimum of 500 cycles.

d) Belleville type compression washers shall be used with all bolted connections properly tightened with a torque wrench. They shall be T&B Catalog Series 60800 or accepted substitution.

e) Taps and/or splices made of dissimilar metals shall be made with accepted connectors of a type where they never come in direct contact with each other.

END OF SECTION

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SECTION 26 05 26 – GROUNDING AND BONDING

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. Provide all labor, materials, and equipment necessary to properly install a grounding system conductor in all new branch wiring and feeder installations, which shall be in full compliance with all applicable codes as accepted by the Authority Having Jurisdiction. The secondary distribution system shall include a grounding conductor in all raceways in addition to the return path of the metallic conduit.

B. In general, all electrical equipment (metallic conduit, motor frames, panelboards, etc.) shall be bonded together with a green insulated or bare copper system grounding conductor in accordance with specific rules of NEC 250 and state codes. Bonding conductor through the raceway system shall be continuous from main switch ground bus to panel ground bar of each panelboard, and from panel grounding bar of each panelboard to branch circuit equipment and devices.

C. All raceways shall have an insulated copper system ground conductor throughout the entire length of circuit installed within conduit in strict accordance with NEC. Grounding conductor shall be included in total conduit fill determining conduit sizes, even though not included or shown on Drawings. Grounding conductors that run with feeders in PVC conduit outside of building(s) shall be bare only.

D. Provide and install all grounding and bonding as required by the National Electrical Code (NEC) including but not limited to NEC 250.

E. Section includes:

1. Grounding Electrodes
2. Grounding Electrode Conductors
3. Equipment Grounding Conductors
4. Bonding
5. Counterpoise System
6. Ground Ring

1.3 REFERENCES

A. ANSI/NFPA 70 National Electrical Code
B. NFPA 780 Standard for the Installation of Lightning Protection Systems
C. UL 467 Grounding and Bonding Equipment

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.5 SUBMITTALS

A. Refer to Division 01 requirements.

B. Submit catalog cut sheets/product data on:

1. Ground rods and couplings.

2. Mechanical connectors.
3. Ground wells.
4. Ground bus bars and associated components.
5. Ground ring conductors.
6. Counterpoise conductors.
7. Exothermic welding materials and molds.
8. Testing equipment and procedures.

C. Product data shall prove compliance with specifications, National Electrical Code, manufacturers’ specifications, and written installation data.

1.6 PROJECT RECORD DOCUMENTS

A. Submit record documents to accurately record actual locations of grounding electrodes.

B. Submit test results of each ground rod. See Section 26 08 13 Tests and Performance Verification of Electrical Systems.

PART 2- PRODUCTS

2.1 ROD ELECTRODES

A. Material: Copper-clad steel.

B. Diameter: 5/8”.

C. Length: 30’ (minimum). Increase lengths as required to meet and achieve specified resistance.

2.2 MECHANICAL CONNECTORS

A. All grounding connectors shall be in accordance with UL 467 and UL listed for use with rods, conductors, reinforcing bars, etc., as appropriate.

B. Connectors and devices used in the grounding systems shall be fabricated of copper or bronze materials, and properly applied for their intended use. Specified items of designated manufacturers indicate required criteria. Equal products may be provided if approved. All connectors and devices shall be compatible with the surfaces being bonded and shall not cause galvanic corrosion by dissimilar metals. Materials in items not listed herein shall be of equal quality to the following specified items:

1. Lugs: Substantial construction, of cast copper or cast bronze, with ground (micro-flat) surfaces, uninsulated compression type, equal to Burndy or T&B. Lightweight and competitive devices shall be rejected.
2. Grounding and Bonding Bushings: Malleable iron, Thomas and Betts (T&B), or equal.
3. Piping Clamps: Burndy GAR-TC Series with two hole compression terminal or T&B equal.
4. Grounding Screw and Pigtail: Raco No. 983 or equal.
5. Building Structural Steel, Existing: Thompson 701 Series heavy duty bronze "C" clamp with two-bolt vise-grip cable clamp.

C. Mechanical lugs or wire terminals shall be used to bond ground wires together or to junction boxes and panel cabinets, and shall be manufactured by Anderson, Buchanan, Thomas and Betts Co., or Burndy.

2.3 WIRE

A. Material: Stranded copper.

B. Size: Size to meet NFPA 70 requirements as a minimum, increase size if called for on drawings, in these specifications, or as required for voltage drop.

C. Insulated THWN (or bare as noted elsewhere).

2.4 GROUNDING WELL COMPONENTS

A. Grass Non-Traffic Areas:

1. Well: Sleeve 18” long, diameter 12” (minimum).
2. Well Cover: High-density plastic, composolite, or cast iron with legend "GROUND" embossed on cover.
3. Material: Structural Plastic, composolite, or concrete.
4. Manufacturer: Carson 2200 Series or equal by Quazite.
5. Increase depth, diameter or size as required to provide proper access at installed location.

B. Paving and Low Traffic Areas:

1. Well: Minimum 12” long by 12” wide by 18” deep with open bottom.
2. Well Cover: Traffic rated for use with "GROUND" embossed on cover.
3. Material: Composolite.
4. Manufacturer: Quazite or equivalent.
5. Increase depth, diameter or size as required to provide proper access at installed location.

2.5 GROUNDING BARS/GROUND BUS (INCLUDING SYSTEMS GROUND BUS/BARS AND GROUND BUS BARS)

A. Ground bars shall be copper of the size and description as shown on the drawings. If not sized on drawings, bus bar shall be minimum 1/4” x 2” bus grade copper, spaced from wall on insulating 2” polyester molded insulator standoff/supports, and be 12” or greater minimum overall length, allowing 2” length per lug connected thereto. Increase overall length as required to facilitate all lugs required while maintaining 2” spacing. Size of bus bar used in main electrical room shall be similar except minimum of 4” high and 24” long.

B. Provide compression type lug for each terminating ground conductor, sized to match conductors. Mount on bus bar at 2” on center spacing. Lugs to be manufactured by Burndy or T&B.

C. Standoff supports to be 2” polyester as manufactured by Glastic #2015-4C or equivalent.

PART 3 - EXECUTION

3.1 GENERAL

A. Install products in accordance with manufacturer’s instructions.

B. Install grounding electrodes conductor, bonding conductors, ground rods, etc. with all required accessories.

C. Grounding shall meet (or exceed as required to meet these specifications) all the requirements of the NEC, the NFPA, and applicable standards of IEEE.

D. Where there is a conflict between these specifications and the above applicable codes/standards, or between this section of these specifications and other sections, then the most stringent requirement shall govern. Where there is an omission of a code/standard requirement in these specifications, then the code/standard requirements shall be complied with.

E. Requirement in these specifications to comply with a specific code/standard article, etc. is not to be construed as deleting of requirements of other applicable codes/standards and their articles.

3.2 GROUNDING ELECTRODES

A. All connections shall be exothermic welded unless otherwise noted herein. All connections above grade and in accessible locations may be by exothermic welding or by braising or clamping with devices UL listed as suitable for use, except in locations where exothermic welding is specifically specified in these specifications or called for on drawings.

B. Each rod shall be die stamped with identification of manufacturer and rod length.

C. Install rod electrodes at locations indicated and/or as called for in these specifications.

D. Ground Resistance:

1. Main Electrical Service (to each building) and Generator Locations:

a) Grounding resistance measured at each main service electrode system and at each generator electrode system shall not exceed 5 ohms.

2. Other Locations:

a) Resistance to ground of all non-current carrying metal parts shall not exceed 5 ohms measured at motors, panels, buses, cabinets, equipment racks, light poles, transformers, and other equipment.

b) Lightning protection system ground locations shall not exceed 5 ohms for the Franklin system measured at ground electrode.

3. Resistance called for above shall be maximum resistance of each ground electrode prior to connection to grounding electrode conductor. Where ground electrode system being measured consists of two or more ground rod electrodes then the resistance specified above shall be the maximum resistance with two or more rods connected together but not connected to the grounding electrode conductor.

E. Install additional rod electrodes as required to achieve specified resistance to ground (specified ground resistance is for each ground rod location prior to connection to ground electrode conductor). Depending on soil condition, etc. of ground rod locations, it has been found that the ground rod lengths required to achieve the specified resistance may range from the minimum specified length to up to 80’ or more in length.

F. Provide grounding well with cover at each rod location. Install grounding well top flush with finished grade.

G. Verify that final backfill and compaction has been completed before driving rod electrodes.

H. Install ground rods not less than 1’ below grade level and not less than 2’ from structure foundation.

3.3 GROUNDING ELECTRODE CONDUCTOR

A. Conductor shall be sized to meet (or exceed as required to meet these specifications and/or drawings) the requirements of NEC 250.

3.4 EQUIPMENT GROUNDING CONDUCTORS

A. Grounding conductors shall be provided with every circuit to meet (or exceed as required to meet these specifications and/or drawings) the requirements of NEC 250.

B. At every voltage level, new portions of the electrical power distribution system shall be grounded with a dedicated copper conductor, which extends from termination back to power source in supply panelboard.

C. Provide separate, insulated (bare if with feeder in PVC conduit outside of building(s)) conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

D. Except as otherwise indicated, each feeder raceway on the load side of the service entrance shall contain a ground conductor sized as indicated and where not shown shall be sized to meet (or exceed as required to meet these specifications and/or drawings) the requirements of NEC 250. Conductor shall be connected to the equipment grounding bus in switchboards and panelboards, to the grounding bus in all motor control centers, and as specified, to lighting fixtures, motors and other types of equipment and outlets. The ground shall be in addition to the metallic raceway and shall be properly connected thereto, using a lug device located within each item enclosure at the point of electric power connections to permit convenient inspection.

E. Provide green insulated ground wire for all grounding type receptacles and for equipment of all voltages. In addition to grounding strap connection to metallic outlet boxes, a supplemental grounding wire and screw equal to Raco No. 983 shall be provided to connect receptacle ground terminal to the box.

F. All plugstrips and metallic surface raceway shall contain a green insulation ground conductor from supply panel ground bus connected to grounding screw on each receptacle in strip and to strip channel. Conductor shall be continuous.

G. Where integral grounding conductor is specified elsewhere in bus duct construction, provide equivalent capacity conductor from supply switchboard or panelboard grounding bus to the bus duct grounding conductor. Bond integral conductor to bus duct enclosure at each tap and each termination.

H. All motors, all heating coil assemblies, and all building equipment requiring flexible connections shall have a green grounding conductor properly connected to the frames and extending continuously inside conduit with circuit conductors to the supply source bus with accepted connectors regardless of conduit size or type. This shall include food service equipment, laundry equipment, and all other "Equipment By Owner" to which an electric conduit is provided under this Division.

3.5 MAIN ELECTRICAL SERVICE

A. Complete installation shall meet and exceed the requirements of the NEC 250.

B. Additional electrodes shall be provided for the main service in sufficient number and configuration to secure resistance specified.

C. Provide and bond to all of the following:

1. Ground rods.
2. Metal water pipe (interior and exterior to building).
3. Building metal frame, structural steel and/or reinforced structural concrete.
4. All piping entering or leaving all buildings (including chilled water piping).
5. Encased electrodes.
6. Ground ring.
7. Site distribution counterpoise ground system.
8. Lightning protection system.

D. A main ground, bare copper conductor, sized per applicable table in NEC 250, but in no case less than #2/0, shall be run in conduit from the main switchgear of each building to the building steel in respective building. This ground conductor shall also be run individually from the main switchgear and be bonded to the main water service ahead of any union in pipe and must be metal pipe of length and location as acceptable by Authorities Having Jurisdiction. Provide properly sized bonding shunt around water meter and/or dielectric unions in the water pipe. Also required is the same size ground wire to ground rod electrode as called for below:

1. Three 30’ ground rods in a delta configuration at no less than 30’ spacing driven to a minimum depth of 30’ plus 1’ below grade.
2. Bond ground rod electrodes together with a bare copper ground conductor that matches size required by applicable table in NEC 250, but in no case less than #2/0.
3. Provide additional rod electrodes as required to achieve specified ground resistance.

E. Ground/bond neutral per NEC 250.

F. A main ground, bare copper conductor, sized per applicable table in NEC 250, but in no case less than #2/0, shall be run in conduit from the main switchgear of each building to a concrete encased electrode per NEC 250.52(A)(3).

G. Bond grounding electrodes to site counterpoise grounding system and lightning protection system where provided.

H. Provide and install ground bus bar on wall near main service disconnect/switchboard. Connect to ground bar in disconnect/switchboard bonded to switchboard/disconnect enclosure/neutral with copper grounding conductor sized per applicable table in NEC 250.

3.6 TRANSFORMER GROUNDING

A. Ground all transformers and enclosures of 120/208V and 277/480V "separately derived systems" as specified herein.

1. Ground per NEC 250 and these specifications.
2. Bond neutral to transformer frame/enclosure and the equipment grounding conductors of the derived system with copper ground conductor sized per applicable table in NEC 250.
3. Connect transformer neutral/ground to grounding electrode per NEC 250 with grounding electrode conductor sized per applicable table in NEC 250.
4. In addition to connection to grounding electrode conductor called for above (i.e. per NEC 250) provide, install and connect supplemental grounding electrode as follows:
   a) Where grounding required per NEC 250 is to building steel/structure, supplement this grounding with connection to nearest available effectively grounded metal water pipe.
   b) Where grounding connection required per NEC 250 is to grounded metal water pipe, supplement this grounding with connection to building steel/structure in addition to any other available electrodes specified in NEC 250.
   c) Where supplemental grounding electrodes required above is a ground rod electrode, provide, install and connect two or more 30’ ground rod electrodes at no less than 30’ spacing, driven vertical to a minimum depth of 30’ plus 1’ below grade.
5. Where neither building steel nor water pipe grounding electrodes are available (i.e. exterior locations with no available water pipe electrode) provide two ground connections, each to two or more 30’ ground rod electrodes at no less than 30’ spacing, driven vertical to a minimum depth of 30’ plus 1’ below grade.
6. Where transformer is mounted exterior to building one of the two ground electrodes required shall be ground rod electrode as called for in 5 above. This ground rod electrode shall also be connected to counterpoise system (wherever counterpoise system is available).
7. Ground to water system service pipe as required by NEC 250.

B. Provide additional ground electrodes as required to achieve specified ground resistance.

C. Where two or more ground electrodes are used at any one required ground location, they shall be bonded together with a copper ground conductor, sized to meet applicable table in NEC 250, but

in no case less than #2/0.

D. Equipment ground conductors shall be provided in addition to above grounding. See “Equipment Grounding Conductor.”

E. Provide and install ground bus bar on wall near transformer (or in associated electrical room for exterior mounted transformers). Connect to ground lug in transformer bonded to transformer enclosure/neutral with copper ground conductor sized per applicable table in NEC 250.

F. Multiple separately derived systems may be grounded as allowed in NEC 250.30(A)(4).

3.7 LIGHTNING PROTECTION SYSTEMS

A. Ground per applicable section on lightning protection system, NFPA 780, and as specified herein. The most stringent requirements shall govern.

B. Bond lightning protection system grounds to electrical service system ground, all piping entering or leaving all buildings, and counterpoise system ground where provided.

C. See Section 26 41 13 Lightning Protection System.

3.8 EXTERIOR GRADE (OR FREE STANDING ABOVE GROUND) MOUNTED EQUIPMENT

A. General:

1. All equipment (including exterior lighting components,chillers, pumps, disconnects, starters, control panels, panels, etc) mounted exterior to building shall have their enclosures grounded directly to a grounding electrode at the equipment location in addition to the building equipment ground connection.

2. Bond each equipment enclosure, metal rack support, mounting channels, etc. to ground electrode system at each rack with an insulated copper ground conductor sized to match the grounding electrode conductor required by applicable table in NEC 250 based on equipment feeder size, but in no case shall conductor be smaller than #6 copper or larger than #2 copper. This connection is in addition to grounding electrode connections required for services.

B. Main Electrical Service Rack Mounted Equipment:

1. Ground: See “Main Electrical Service.”

2. Bond all metal parts as noted above.

C. Electrical Sub service Rack Mounted Equipment.

1. Ground per “Main Electrical Service,” except do not bond neutral to ground.

2. Bond all metal parts as noted above.

D. Electrical Equipment Connection Rack Mounted Equipment.

1. Bond all metal parts as noted above.

E. Grounding Electrodes (Ground Electrodes System) shall be:

1. Located at each rack location.

2. For service equipment: Ground electrode required per “Main Electrical Service.”

3. For equipment connection equipment: Two or more 20’ ground rods at no less than 30’ spacing, driven vertical to a minimum depth of 30’ plus 1’ below grade. Bond the two or more ground rods together with a size to meet applicable table in NEC 250, but no less than a #2 copper ground conductor. Provide additional rod electrodes as required to achieve specified ground resistance.

F. Complete installation shall exceed the minimum requirements of NEC 250 and, when applicable,

NFPA 780.

3.9 ROOF MOUNTED EQUIPMENT

A. Bond all roof mounted electrical equipment to lightning protection system (when provided) per NFPA 780.

B. Where lightning protection system is not provided, ground/bond all roof mounted electrical equipment to building steel and to two or more 30’ ground rods at no less than 30’ spacing driven vertically to a minimum depth of 30’ plus 1’ below grade.

1. Bond the two or more ground rods together with a Class I or Class II as required per NFPA 780 lightning protection main copper conductor.

2. Provide additional rod electrodes as required to achieve specified ground resistance.

3. Complete installation shall exceed the minimum requirements of NFPA 780.

3.10 LIGHTING FIXTURES

A. All new fixtures in building interior, and exterior fixtures shall be provided with green grounding conductor, solidly connected to unit. Individual fixture grounds shall be with lug to fixture body, generally located at point of electrical connection to the fixture unit.

B. All suspended fixtures and those supplied through flexible metallic conduit shall have green ground conductor from outlet box to fixture. Cord connected fixtures shall contain a separate green ground conductor.

C. Pole Light Fixtures:

1. Metal Pole Light Fixtures:

a) Freestanding pole mounted lighting fixtures shall each have a Class I or Class II lightning protection main copper down conductor connected to grounding electrodes at base of pole.

b) Conductor shall be bonded to metal pole via UL listed ground clamp suitable for use. Locate ground lug opposite to handhole (or adjacent if visible through handhole).

2. Concrete or Non-Metallic Pole:

a) Freestanding pole mounted lighting fixtures shall each have a Class I or Class II lightning protection main copper down conductor connected to grounding electrodes at base of pole.

b) Conductor shall be extended from grounding electrode to top of pole and terminate at the top of pole in a Class I or Class II copper lightning protection air terminal.

c) Each metal part of light fixture assembly, bracket, ballast cabinet, disconnect, transformer, etc. that is mounted to pole shall be bonded to down conductor.

3. Fixtures located on elevated roadway ramps shall be specially provided with a connection to lightning counterpoise grounding system, properly installed.

4. Grounding electrode(s) at each pole shall be connected (bonded) to site distribution counterpoise system.

5. Grounding Electrodes:

a) Two or more 10’ ground rods at no less than 10’ spacing shall be driven vertically to a minimum depth of 10’ plus 1’ below grade.

b) Bond the two or more ground rod electrodes together with a Class I or Class II lightning protection main copper conductor.

c) Provide additional rod electrodes as required to achieve specified ground resistance.

d) The two or more grounding rod electrodes arel be installed at each light pole.

6. Installation shall exceed minimum requirements of NFPA 780.

3.11 PULLBOX, MANHOLE, HANDHOLE GROUNDING.

A. One 30’ ground rod electrode shall be driven vertically to a minimum depth of 30’ plus 1’ below grade in each manhole, handhole or pullbox (in ground).

B. The complete installation shall exceed the minimum requirements of the NEC.

C. Provide additional ground rod electrodes as required to provide resistance called for herein.

D. Where more than one ground rod electrode is required bond the two or more ground rod electrodes together with a copper ground conductor.

E. Bond to counterpoise system (whenever counterpoise system is provided.)

F. Bond grounding electrode to all exposed metal parts of manhole, handhole, and pullbox (including metal cover) with #6 copper ground conductor. Connect to ground rod electrode with exothermic weld. Connect to metal cover with exothermic weld. Connect to other metal parts with exothermic weld or UL accepted grounding clamp. Provide 3’ or more slack ground cable on cover connection as required to facilitate removal of cover.

3.12 HAZARDOUS LOCATIONS

A. Ground in hazardous locations shall be done in accordance with applicable portions of NEC 500, 501, 502, 503, 511 and 514.

3.13 GROUND RING

A. Provide complete underground building perimeter ground ring system, completely encircling each building.

B. Conductor shall be minimum of Class II lightning protection copper conductor (bare).

C. Install at not less than 2-1/2’ depth into earth.

D. Install ground rods (minimum 30’ long) every 150’ section of ground ring conductor.

E. Bond ground ring to building foundation steel every 150’ around building perimeter, bond to any and all electrical and piping systems that cross the ground ring system, bond to lightning protection down conductors and to any lightning or other earth grounding electrodes that may be present on the premises.

F. Bond to building service and counterpoise ground systems.

3.14 MISCELLANEOUS GROUNDING CONNECTIONS

A. Provide bonding to meet regulatory requirements.

B. Required connections to building steel shall be with UL accepted non-reversible crimp type ground lugs exothermically welded to bus bar that is either exothermically welded to steel or bolted to steel in locations where weld will affect the structural properties of the steel. Required connections to existing building structural steel purlins/I beams shall be with heavy duty bronze "C" clamp with two bolt vise-grip cable clamp.

C. Grounding conductors shall be installed to permit the shortest and most direct path from equipment to ground; be installed in conduit; be bonded to conduit at both ends when conduit is metal; have connections accessible for inspection; and made with accepted solderless connectors brazed (or bolted) to the equipment or to be grounded; in NO case be a current carrying conductor; have a green jacket unless it is bare copper; be run in conduit with power and branch circuit conductors. The main grounding electrode conductor shall be exothermically

welded to ground rods, water pipe, and building steel.

D. All surfaces to which grounding connections are made shall be thoroughly cleaned to maximum conductive condition immediately before connections are made thereto. Metal rustproofing shall be removed at grounding contact surfaces, for 0 ohms by digital Vm. Exposed bare metal at the termination point shall be painted.

E. All ground connections that are buried or in otherwise inaccessible locations, shall be welded exothermically. The weld shall provide a connection which shall not corrode or loosen and which shall be equal or larger in size than the conductors joined together. The connection shall have the same current carrying capacity as the largest conductor.

F. Install ground bushings on all metal conduits entering enclosures where the continuity of grounding is broken between the conduit and enclosure (i.e. metal conduit stub-up into a motor control center enclosure or at ground bus bar). Provide an appropriately sized bond jumper from the ground bushing to the respective equipment ground bus or ground bus bar.

G. Install ground bushings on all metal conduits where the continuity of grounding is broken between the conduit and the electrical distribution system (i.e. metal conduit stub-up from wall outlet box to ceiling space. Provide an appropriately sized bond jumper from the ground bushing to the respective equipment ground bus or ground bus bar.

H. Each feeder metallic conduit shall be bonded at all discontinuities, including at switchboards and all subdistribution and branch circuit panels with conductors in accordance with applicable table in NEC 250 for parallel return with respective interior grounding conductor.

I. Grounding provisions shall include double locknuts on all heavywall conduits.

J. Bond all metal parts of pole light fixtures to ground rod at base.

K. Install grounding bus in all existing panelboards of remodeled areas, for connection of new grounding conductors, connected to an accepted ground point.

L. Bond together reinforcing steel and metal accessories in pool and fountain structures and bond to electrical system per NEC.

M. Where reinforced concrete is utilized for building grounding system, proper reinforced bonding shall be provided to secure low resistance to earth with "thermite" type devices, and #10AWG wire ties shall be provided to not less than ten full length rebars which contact the connected rebar (by Division 26 Contractor). Provide size and length of rod to meet NEC requirements.

3.15 GROUNDING BAR/GROUND BUS (INCLUDING SYSTEMS GROUND BUS/BAR ON GROUND BUS/BAR) INSTALLATION

A. Where indicated on the drawings, provide and install grounding bar/ground bus (bus bar). These bus installations are intended to provide a low-impedance "earthing" path for surge voltages, which are electrically "clamped" and shunted to earth by variable-impedance surge protective devices. Metal sheaths of underground cables are also to be grounded thereto at points of building entrance.

B. Mount bolt tapping lugs with hex head bolts to bus bar at 2” o.c. spacing, one for each ground conductor.

C. Mount bus bar to wall using 2” polyester molded insulator stand-off.

D. Extend a #2/0 (minimum size) or larger THWN insulated copper ground conductor (if larger size is called for on drawings or required by NEC for service ground, etc.) in PVC conduit to accepted service ground installation or ground bus/bar in main service equipment enclosure.

E. Extend #6 insulated copper ground wire from respective bus/bar to each 'local' ground bus/bar in each cabinet for Division 28 systems.

F. Systems grounding bus/bar must be connected with #2/0 insulated copper conductor to grounding electrodes system as defined in NEC Article 800.100(B).

3.16 COUNTERPOISE SYSTEM

A. Install counterpoise and ground over all sections of underground ductbanks, conduits, or cables outside (exterior) to building.

B. No. 2 bare stranded copper counterpoise shall be run 6” above all underground duct banks, conduits and cables outside (exterior) to building.

C. Provide one counterpoise conductor for ductbanks (or conduit groupings) 12” wide or less. Provide two counterpoise conductors above outside edge of ductbank (or conduit groupings) over 12” wide.

D. Counterpoise shall run to building and be grounded at each building to the main building electrical service ground rod electrode (exterior to building). Counterpoise shall be bonded to ground rod at all light poles, pullboxes, manholes, handholes and at each building. Provide and install appropriate ground rod every 150’ length of counterpoise conductor. See “Grounding Electrodes.” Counterpoise conductor shall not be run into interior of building. Route counterpoise underground around exterior perimeter of building to main service ground rod installation.

3.17 COMMUNICATIONS SYSTEMS

A. Provide and install all grounding as required by NEC Article 800 and where available on project: Articles 810 (Radio and Television Equipment); 820 (Community Antenna Television and Radio Distribution Systems); and 830 (Network-Powered Broadband Communications Systems.

B. Provide and install grounding electrode at point of entry of communication cables and bond to service entrance grounding electrodes per NEC 800. Install ground bus bar at point of entry of communications cable and connect electrode to ground bus. Connect communications cable metal sheath and surge protection devices to ground bar.

3.18 TESTING AND REPORTS

A. Raceway Continuity: Metallic raceway system as a component of the facilities ground system shall be tested for electrical continuity. Resistance to ground throughout the system shall not exceed specified limits.

B. Ground resistance measurements shall be made on each system utilized in the project. The ground resistance measurements shall include building structural steel, driven grounding system, water pipe grounding system and other accepted systems as may be applicable. Ground resistance measurements shall be made in normally dry weather, not less than 24 hours after rainfall, and with the ground under test isolated from other grounds and equipment. Resistances measured shall not exceed specified limits.

C. Upon completion of testing, the testing conditions and results shall be certified by the Contractor and submitted to the A/E as called for in Section Tests and Performance Verification of Electrical Systems.

3.19 INTERFACE WITH OTHER PRODUCTS

A. Interface with site grounding system.

B. Interface with lightning protection system installed under Section 26 41 13 Lightning Protection System.

C. Interface with communications system installed under Division 27 sections.

3.20 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

END OF SECTION

SECTION 26 05 29 - HANGERS AND SUPPORTS

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. Furnish and install all supports, hangers and inserts required to mount fixtures, conduit, cables, pullboxes and other equipment furnished under this Division.

B. Section includes:

1. Conduit and equipment supports.

2. Anchors and fasteners.

1.3 REFERENCES

A. NECA National Electrical Contractors Association

B. ANSI/NFPA 70 National Electrical Code

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

PART 2- PRODUCTS

2.1 PRODUCT REQUIREMENTS

A. Materials and Finishes: Provide corrosion resistance.

B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Provide anchors, fasteners, and supports in accordance with NECA National Electrical Installation Standards.

C. Do not fasten supports to pipes, ducts, mechanical equipment or conduit.

D. Do not use spring steel clips and clamps.

E. Obtain permission from A/E before using powder-actuated anchors.

F. Obtain permission from A/E before drilling or cutting structural members.

G. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

H. Install surface-mounted cabinets and panelboards with minimum of four anchors.

I. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1” off wall.

J. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

K. All items shall be supported from the structural portion of the building.

L. This Contractor shall lay out and install his work in advance of the laying of floors or walls, and shall furnish and install all sleeves that may be required for openings through floors, wall, etc. Where plans call for conduit to be run exposed, this Contractor shall furnish and install all inserts and clamps for the supporting of conduit. If this Contractor does not properly install all sleeves and inserts required, he will be required to do the necessary cutting and patching later at his own expense to the satisfaction of the Architect.

M. All conduits shall be securely fastened in place per NEC. Hangers, supports or fastenings shall be provided at each elbow and at the end of each straight run terminating at a box or cabinet. The use of perforated iron for supporting conduits will not be permitted. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and cables. Horizontal and vertical conduit runs may be supported by one-hole malleable straps, clamp-backs, or other accepted devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.

N. Where two or more conduits are run parallel or in a similar direction, they shall be grouped together and supported by means of Kindorf type trapeze hanger system (racking) consisting of concrete inserts, threaded solid rods, washers, nuts and galvanized "L" angle iron, or Unistrut cross members. These conduits shall be individually fastened to the cross member of every other trapeze hanger with galvanized cast one hole straps, clamp backs, bolted with proper size cadmium machine bolts, washers and nuts. If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt type clamps shall be used at the end of a conduit run and at each elbow. J-bolts, or accepted clamps, shall be installed on each third intermediate trapeze hanger to fasten each conduit.

O. Hanger assemblies shall be protected after fabrication by galvanizing. Hangers for PVC coated conduit shall be PVC coated galvanized conduit or stainless steel.

P. On concrete or brick construction, insert anchors shall be installed with round head machine screws. In wood construction, round head screws shall be used. An electric or hand drill shall be used for drilling holes for all inserts in brick, concrete or similar construction. In brick, inserts shall be near center of brick, not near edge or in joint. Where steel members occur, same shall be drilled and tapped, and round head machine screws shall be used. All screws, bolts, washers, etc., used for supporting conduit or outlets shall be fabricated from rust-resisting metal, or accepted substitution. Fasteners similar to "TAP-CON" self tapping power driven type are acceptable. Plastic anchors are not acceptable.

Q. Conduit supporting devices such as spring type conduit clips manufactured by Caddy Corporation may not be used.

R. Threaded rod hangers shall be galvanized continuous thread type, minimum 3/8” diameter.

S. Concrete/insert anchors, threaded rods, or similar fasteners installed on side or bottom of pre-stressed beams are not acceptable.

END OF SECTION

SECTION 26 05 33 - CONDUIT

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 requirements for electrical conduit.

B. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for the following:

1. Rigid Metal Conduit (RMC) NEC 344
2. Rigid Metal Conduit PVC Coated (RMC-PVC Coated) NEC 344
3. Flexible Metal Conduit (FMC) NEC 348
4. Liquidtight Flexible Metal Conduit (LFMC) NEC 350
5. Electrical Metallic Tubing (EMT) NEC 358
6. Rigid Polyvinyl Chloride Conduit (Type PVC) NEC 352
7. Fittings and Conduit Bodies
8. Cast Boxes and Sheet Metal Outlet Boxes

1.3 REFERENCES

A. ANSI C80.1 Electrical Rigid Steel Conduit, Zinc Coated
B. ANSI C80.3 Steel Electrical Metallic Tubing
C. ANSI/NEMA FB 1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
D. ANSI/NFPA 70 National Electrical Code
E. ANSI/UL 1 Standard for Flexible Metal Conduit
F. ANSI/UL 360 Standard for Liquid-Tight Flexible Steel Conduit
G. ANSI/UL 514B Conduit, Tubing and Cable Fittings
H. ANSI/UL 797 Electrical Metallic Tubing-Steel
I. NECA Standard Practice of Good Workmanship in Electrical Contracting
J. NEMA RN 1 Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit (MC).
K. NEMA TC 2 Electrical Polyvinyl Chloride (PVC) Conduit (EPC 40, EPC 80)
L. NEMA TC 3 Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.5 DESIGN REQUIREMENTS

A. Conduit Size: ANSI/NFPA 70. (See Drawings and this and other sections of these Specifications for additional requirements).

B. Raceways and conduits shall begin at an acceptable enclosure and terminate only in another such enclosure except conduit/raceway stub-outs.

C. A raceway shall be provided for all electrical power and lighting, and electrical systems unless

specifically specified otherwise.

1.6 SUBMITTALS

A. Submit catalog cut sheet showing brand of conduit to be used and showing that conduit is UL listed and labeled, and manufactured in the United States.

B. Submit catalog cut sheet on all types of conduit bodies and fittings.

C. Product data shall be submitted for acceptance on:

1. Conduits
2. Boxes
3. Conduit straps, hangers and fittings
4. PVC solvent(s) and bending box
5. Fitting entering and leaving the ground or pavement
6. For pull boxes and junction boxes, submit product data showing dimensions, covers, and construction.

D. Product data shall prove compliance with Specifications, National Electrical Code, National Board of Fire Underwriters, manufacturer’s specifications and written installation data.

1.7 PROJECT RECORD DOCUMENTS

A. Submit record documents to accurately record actual routing of conduits larger than 1.25”.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, properly store and protect products at the site.

B. Accept conduit on site. Inspect for damage.

C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

D. Protect PVC conduit from sunlight.

1.9 PROJECT CONDITIONS

A. Verify that field measurements are as shown on drawings.

B. Verify routing and termination locations of conduit prior to rough-in.

C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

PART 2 - PRODUCTS

2.1 GENERAL

A. All conduit shall bear UL label or seal and shall be manufactured in the United States.

B. Conduit systems and all related fittings, boxes, supports, and hangers must meet all the requirements of national, state, and other federal codes where applicable.

2.2 MINIMUM TRADE SIZE

A. Homeruns, Underground Branches and Aboveground Branches: 3/4” C.
B. Switchlegs: 1/2” C.

2.3 RIGID METAL CONDUIT (RMC)

A. Comply with:

1. ANSI C80.1.
2. UL 6.
3. NEC 344.

B. Conduit Material:
1. Zinc coated or hot dipped galvanized steel.

C. Fittings:
1. Threaded.
2. Insulated bushings shall be used on all rigid steel conduits terminating in panels, boxes, wire gutters, or cabinets, and shall be impact resistant plastic molded in an irregular shape at the top to provide smooth insulating surface at top and inner edge. Material in these bushings must not melt or support flame.
3. Zinc plated or hot dipped galvanized malleable iron or steel.

D. Conduit Bodies (comply with):
1. ANSI/NEMA FB 1.
2. Threaded hubs.
3. Zinc plated or hot-dipped galvanized malleable iron.

2.4 FLEXIBLE METAL CONDUIT (FMC)

A. Comply with:
1. NEC 348.
2. ANSI/UL 1.

B. Conduit Material:
1. Steel, interlocked.

C. Fittings:
1. ANSI/NEMA FB 1.
2. ANSI/UL 514B.
3. Die Cast.
4. Malleable iron, zinc plated.
5. Threaded rigid conduit to flexible conduit coupling.
6. Direct flexible conduit bearing set screw type not acceptable.

2.5 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Comply with:
1. NEC 350.
2. ANSI/UL 360.

B. Conduit Material:
1. Flexible hot-dipped galvanized steel core, interlocked.
2. Continuous copper ground built into core up to 1-1/4” size.
3. Extruded polyvinyl gray jacket.

C. Fittings:
1. Threaded for rigid conduit connections.
2. Accepted for hazardous locations where so installed.
3. Provide sealing washer in wet/damp locations.
4. Compression type.
5. ANSI/NEMA FB 1.
6. ANSI/UL 514B.
7. Die Cast
8. Zinc plated malleable iron or steel.

2.6 ELECTRICAL METALLIC TUBING

A. Comply with:
   1. UL 797.
   2. ANSI C80.3.
   3. NEC 358.
   4. ANSI/UL 797.

B. Conduit material:
   1. Galvanized steel tubing.

C. Fittings:
   1. ANSI/NEMA FB 1.
   2. Set screw.
   3. Die Cast.
   4. Concrete tight.

2.7 RIGID POLYVINYL CHLORIDE CONDUIT

A. Comply with:
   1. NEMA TC 2.
   2. UL 651.
   3. NEC 352.

B. Conduit Material:
   1. High impact PVC, tensile strength 55 psi, flexural strength 11000 psi.

C. Fittings:
   1. NEMA TC 3.
   2. UL 514.

D. General:
   1. UL listed and identified.
   2. Conform to all national, state and local codes.
   3. Manufacturer shall have five years experience in manufacturing PVC conduits.

2.8 EXPANSION FITTINGS

A. Expansion fittings shall be:
   1. UL listed, hot dipped galvanized inside and outside providing a 4” expansion chamber when used with rigid conduit, electrical metallic tubing, or:
   2. Be polyvinyl chloride and shall meet the requirements of and as specified elsewhere for non-metallic conduit and shall provide a 6” expansion chamber.
   3. Hot dipped galvanized expansion fitting shall be provided with an external braided grounding and bonding jumper with accepted clamps, UL listed for the application.
   4. Expansion fitting, UL listed for the application and in compliance with the NEC without the necessity of an external bonding jumper may be considered. Submit fitting with manufacturer's data and UL listing for acceptance prior to installation.

2.9 SURFACE RACEWAYS(Only acceptable where indicated on drawings)

A. Provide a complete and operating system for the following:
   1. Surface Metal Raceways
   2. Multi-Outlet Assemblies
   3. Wireways
   4. Wall Duct

B. Surface Metal Raceway with Duplex Receptacles and Communication Systems Outlet:

   1. Description: Two-piece construction, single, double, or triple metal raceway system with cover, devices and device covers.
   2. Size: Single 2.83 sq. in., 1-5/8” x 2-1/8”; double (2) 2.82 sq. in., 1-5/8” x 4-1/4:.

3. Finish: Gray enamel base. Paint as directed by Architect.
4. Fittings: Provide fittings as required for a complete and enclosed system including, wall box connector, end feed, panel connector, T’s, couplings, elbows, bridges, end blanks, etc.
5. Device and Device Covers: Receptacles for power and grommetted holes for communication systems are to be as shown on the contract drawings.
6. Wiring Devices: Power receptacles are to be minimum 20 amp., 120V specification grade (gray) or greater.

C. Surface Metal Raceway(Only acceptable where noted on drawings)

1. Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.
2. Size: As required to house wires and match connection equipment.
3. Finish: Ivory enamel, paint as directed by the Architect.
4. Fittings Boxes, and Extension Rings: furnish manufacturer’s standard accessories, complete as required for a complete enclosed installation.

D. Multi-Outlet Assemblies (Single Receptacles)

1. Multi-Outlet Assembly: Sheet metal channel with fitted cover, with pre-wired receptacles, suitable for use as multi-outlet assembly.
2. Size: Length as indicated on Drawings.
3. Receptacles: NEMA WD6, 15 amp or 20 amp, single receptacle as indicated.
4. Receptacle Spacing: as indicated.
5. Receptacle Color: Gray.
6. Channel Finish: Gray enamel, paint as directed by Architect.
7. Fittings: Furnish manufacturer’s standard couplings, elbows, outlet and device boxes and connectors.
8. Where more than one circuit is feeding a multi-outlet assembly, receptacles are to be wired alternately.

E. Wireway:

1. Description: General purpose, oil-tight and dust-tight or rain-tight type wireway. Provide type required to meet applicable code requirements.
2. Knockouts: Manufacturer’s standard.
3. Cover: Hinged cover with full gasketing for rain-type and oil-tight types.
4. Connector: Slip-in for general purpose and rain-tight types and flanged for oil-tight types.
5. Fittings: Lay-in type with removable top, bottom, and side; captive screws for general purpose, and drip shield for rain-tight type, and removable top for oil-tight type.
6. Finish: Rust inhibiting primer coating with gray enamel finish.

F. Wall Duct:

1. Description: Sheet metal wall duct suitable for installation of cables; with flush covers and accessories.

PART 3 - EXECUTION

3.1 LOCATION REQUIREMENTS

A. Underground Installations:
1. Use rigid non-metallic conduit (PVC) only unless local Authority Having Jurisdiction or applicable codes/utility requirements, etc. require rigid steel conduit.
2. All conduits or elbows entering, or leaving the ground shall be rigid steel conduit coated with asphaltic paint.
3. All underground raceways (with exception of raceways installed under floor slab) shall be installed in accordance with NEC 300.5, except the minimum cover for any conduit shall be 2’. Included under this Article shall be the responsibility for verifying finished lines in areas

where raceways will be installed underground before the grading is complete.

4. Where rigid metal conduit is installed underground as noted above it shall be coated with waterproofing black mastic before installation, and all joints shall be recoated after installation.
5. All underground service lateral raceways shall be protected as required by NEC 300.5, including requirements for installation of warning tape.

B. In Slab Above or on Grade:
   1. Use coated rigid steel conduit, or rigid non-metallic conduit.
   2. Coating of metallic conduit to be black asphaltic or PVC.

C. Penetration of Slab:
   1. Exposed Location:
      a) Where penetrating a floor in an exposed location from underground or in slab, a black mastic coated or PVC coated galvanized rigid steel conduit shall be used.
   2. Concealed Location:
      a) Where penetrating a floor in a location concealed in block wall and acceptable by applicable codes, rigid non-metallic conduit may be used up to first outlet box, provided outlet box is at a maximum height of 40” above finished floor.
      b) Where penetrating a floor in location other than that above use a black mastic coated or PVC coated galvanized rigid steel conduit.

D. Outdoor Location:
   1. Above Grade:
      a) Where penetrating the finished grade, black mastic coated or PVC coated galvanized rigid steel conduit shall be used.
      b) In general, all exterior conduit runs shall be rigid steel conduit and threaded connectors as specified elsewhere.
      c) Electrical metallic tubing (thin wall) is permitted under roof, overhangs, etc. provided it is not subjected to physical damage and is not in direct contact or directly subject to exterior elements including sunlight.
   2. Metal Canopies:
      a) Conduit runs, except for canopy lighting raceways, are not to be run on (top or bottom) metal canopies of roof systems. All new conduit shown on or at these areas shall be run underground. Clamp back spacers shall be used on all canopies to prevent galvanic action from dissimilar metals. Conduits installed exposed from building structure to metal canopies will not be permitted.
   3. Roofs:
      a) Conduit is not to be installed on roofs, without written authorization by A/E for specific conditions.
      b) When accepted by written authorization, conduit shall comply with the following:
         1. Be PVC coated rigid galvanized metal conduit.
         2. All fittings, etc. are to be PVC coated.
         3. Conduit shall be supported above roof at least 6” using accepted conduit supporting devices. Refer to applicable sections of specifications on roofing, etc.
         4. Supports to be fastened to roof using roofing adhesive or means accepted by roofing contractor.

E. Interior Dry Locations:
   1. Concealed: Use rigid galvanized steel conduit and electrical metallic tubing. Rigid non-metallic conduit may be used inside block walls up to first outlet to a maximum of 40” AFF except where prohibited by the NEC (Places of Assembly, etc.).
   2. Exposed: Use rigid galvanized steel or electrical metallic tubing. EMT may only be used where not subject to damage, which is interpreted by this specification to be above 90” AFF.

3. Concealed or Exposed Flexible Conduit:

a) Concealed flexible steel conduit or seal tight flexible steel conduit in lengths not longer than 6’ in length with a ground conductor installed in the conduit or an equipment ground conductor firmly attached to the terminating fitting at the extreme end of the flex. Exposed flexible steel conduit or seal tight flexible steel conduit shall not exceed 2’ in length, unless written authorization by A/E for specific conditions is granted.

F. Interior Wet and Damp Locations:
1. Use rigid galvanized steel, metal conduit in locations not exposed to the public.

G. Concrete Columns or Poured in-place Concrete Wall Locations:
1. Use rigid non-metallic conduit. Penetration shall be by accepted metal raceway (i.e. metal conduit as required elsewhere in these specifications).

3.2 ADDITIONAL REQUIREMENTS FOR RIGID STEEL CONDUIT

A. Rigid steel conduit shall be cut and threaded with tools accepted for the purpose and by qualified personnel.

1. Accepted pipe vise.

2. Roller/bade type cutter or band saw.

3. Reamer capable of completely removing all ridges or burrs left by the cutter. Reaming with pliers is not acceptable.

B. Hangers shall be installed 8’ apart.

3.3 ADDITIONAL REQUIREMENTS FOR EMT

A. Electrical metallic tubing (thin wall) may be installed inside buildings above ground floor where not subject to mechanical injury.

B. All cuts shall be reamed smooth and free of sharp and abrasive areas by use of an accepted reamer.

3.4 ADDITIONAL REQUIREMENTS FOR FLEXIBLE STEEL CONDUIT AND SEAL-TITE FLEXIBLE STEEL CONDUIT

A. Shall be properly grounded.

B. Shall be installed with accepted fittings.

C. Flexible steel conduit shall not exceed 6’ in length except when fished down in existing walls. When fished in existing walls, a junction box shall be provided within 12” of where the flex exits the wall and a transition shall be made to a suitable rigid conduit for the location such as EMT or galvanized rigid metal conduit.

3.5 ADDITIONAL REQUIREMENTS FOR RIGID NON-METALLIC CONDUIT (PVC CONDUIT)

A. Rigid non-metallic PVC conduit is not allowed anywhere inside building(s) except underground, in slab, in poured in place concrete, and in block wall up to first outlet box (if not over 40” AFF) if allowed by codes. Rigid non-metallic PVC conduit may be used exterior to building as stated elsewhere in these specifications.

B. Join rigid non-metallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

C. Threads will not be permitted on rigid non-metallic PVC conduit and fittings, except for rigid steel to rigid non-metallic PVC couplings.

D. Installation of rigid non-metallic PVC conduit shall be in accordance with manufacturer's recommendations.

E. Rigid non-metallic PVC conduit shall not be used to support fixture or equipment.

F. Field bends shall be made with accepted hotbox. Heating with flame and hand held dryers are prohibited.

3.6 SUPPORTS

A. Arrange supports to prevent misalignment during wiring installation.

B. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

C. Group related conduits; support using conduit rack. Construct rack using steel channel; (minimum 24” increase distance as required) provide space on each for 25 percent additional conduits.

D. Fasten conduit supports to building structure and surfaces under provisions of Section 26 05 29 Hangers and Supports.

E. Do not support conduit with wire, metal banding material, or perforated pipe straps. Remove wire used for temporary supports

F. Do not attach conduit to ceiling support wires.

G. Conduits shall not be supported from ceiling grid supports, plumbing pipes, duct systems, heating or air conditioning pipes, or other building systems.

H. Supporting conduit and boxes with wire is not accepted. All raceways except those from surface-mounted switches, outlet boxes or panels shall be supported with clamp fasteners with toggle bolt on hollow walls, and with lead expansion shields on masonry. Tapcons are acceptable when installed in accordance with manufacturer’s instructions.

3.7 EXPANSION FITTINGS

A. Provide expansion fittings to accommodate expansion and deflection where conduit crosses control and expansion joints.

B. Expansion fittings shall be installed in the following cases: In each conduit run wherever it crosses an expansion joint in the concrete structure; on one side of joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion equal to at least three times the normal width of joints; in each conduit run which mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other; in straight conduit run above ground which is more than 100’ long and interval between expansion fittings in such runs shall not be greater than 100’.

3.8 GROUNDING

A. All raceways shall have a copper system ground conductor throughout the entire length of circuit installed within conduit in strict accordance with NEC Codes.

B. Grounding conductor shall be included in total conduit fill determining conduit sizes, even though not included or shown on drawings.

C. Grounding conductors run with exterior/ underground feeders shall be bare only.

D. Grounding conductors run with feeders shall be bonded to portions of conduit that are metal by accepted ground bushings.

E. See other sections of these specifications for additional requirements.

F. Grounding conductors (including lightning protection down conductors) run in metal conduit shall

be bonded to metal conduit at both ends.

3.9 GENERAL

A. Install conduit in accordance with NECA Standard Practice of Good Workmanship in Electrical Contracting. Contractor shall layout all work prior to rough-in.

B. Install nonmetallic conduit in accordance with manufacturer's instructions.

C. Arrange conduit to maintain headroom and present neat appearance.

D. Route conduit installed above accessible ceilings or exposed to view parallel or perpendicular to walls. Do not run from point-to-point. Diagonal runs are not acceptable.

E. Route conduit in and under slab from point-to-point.

F. Do not cross conduits in slab.

G. Maintain adequate clearance between conduit and piping.

H. Maintain 12” clearance between conduit and surfaces with temperatures exceeding 104 degrees F (40 degrees C).

I. Cut conduit square using saw or pipe cutter; de-burr cut ends.

J. Bring conduit to shoulder of fittings; fasten securely.

K. Use conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

L. Install no more than equivalent of three 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2” size.

M. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

N. Provide and install pullboxes, junction boxes, fire barrier at fire rated walls etc., as required by NEC Article 300, whether shown on Drawings or not.

O. Provide continuous fiber polyline 1000 lb. minimum tensile strength pull string in each empty conduit except sleeves and nipples. This includes all raceways which do not have conductors furnished under this Division of the Specifications. Pullcord must be fastened to prevent accidental removal. A phenolic or brass nameplate shall be attached to each end indicating the location of both ends of conduit as follows: THIS END = "LOCATION," OTHER END = "LOCATION."

P. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

Q. Grounding and bonding conduit under provisions of Section 26 05 26 Grounding and Bonding.

R. Identify conduit under provisions of Section 26 05 53 Identification for Electrical Systems.

S. Install all conduits concealed from view unless specifically shown otherwise on drawings

T. Rigid steel box connections shall be made with double locknuts and bushings.

U. All raceways shall be kept clear of plumbing fixtures to facilitate future repair or replacement of said fixtures without disturbing wiring. Except where it is necessary for control purposes, all raceways shall be kept away from items producing heat.

V. All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.

W. All raceways shall be run from outlet to outlet as shown on the Drawings, unless permission is granted to alter arrangement shown. If permission is granted arrangement shall be marked on field set of Drawings as previously specified.

X. Spare conduit stubs shall be capped and location and use marked with concrete marker set flush with finish grade. Marker shall be 6” round x 6” deep with appropriate symbol embedded into top to indicate use. Also, tag conduits in panels where originating.

Y. All conduit stubbed above floor shall be strapped to Kindorf channel supported by conduit driven into ground or tied to steel. Spare conduit stubs shall be capped with a UL listed and accepted cap or plug for the specific intended use and identified with ink markers as to source and labeled "Spare."

Z. All connections to motors or other vibrating equipment including dry type transformers or at other locations where required shall be made with not less than 12” of flexible steel conduit. Use angle connectors wherever necessary to relieve angle strain on flex conduit.

AA. Provide conduit seal-offs wherever conduit crosses obvious temperature changes (i.e. from inside to outside of coolers, freezers, etc.).

BB. Route conduit through roof openings for piping and ductwork, or through suitable roof flashing or boot. Coordinate location with roofing installation specified under other sections of these specifications. Pitch pockets are not acceptable.

CC. All raceways shall be run in neat and workmanlike manner and shall be properly in accordance with latest edition of NEC with accepted conduit clamps, hanger rods and structural fasteners.

DD. All raceway runs, whether terminated in boxes or not, shall be capped during the course of construction and until wires are pulled in, and covers are in place. No conductors shall be pulled into raceways until construction work which might damage the raceways has been completed.

EE. Electrical raceways shall be supported independently of all other systems and supports, and shall in every case avoid proximity to other systems which might cause confusion with such systems or might provide a chance of electrolytic actions, contact with live parts or excessive induced heat.

END OF SECTION

SECTION 26 05 34 - OUTLET BOXES

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 wall and ceiling outlet boxes (and/or small junction/pullboxes).

B. Provide and install all outlet boxes (flush or surface) complete with all accessories as required to facilitate installation of electrical system and as required by the NEC.

1.3 REFERENCES

A. ANSI/NEMA FB 1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable

B. ANSI/NEMA OS 1 Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

C. ANSI/NFPA 70 National Electrical Code

D. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.5 SUBMITTALS

A. Submit catalog cut sheets/product data on:

1. Surface cast boxes.

B. For pullboxes and junction boxes not covered in Section 26 05 35 Pull and Junction Boxes, submit product data showing dimensions, covers, and construction.

1.6 PROJECT CONDITIONS

A. Verify field measurements are as shown on Drawings.

B. Verify locations of outlets in offices and work areas prior to rough-in.

C. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose.

PART 2 - PRODUCTS

2.1 GENERAL

A. All boxes and fittings shall be labeled by Underwriters Laboratories.

B. Provide box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, outlet boxes, and corrosion-resistant knockout closures compatible with outlet boxes being used and meeting requirements of individual wiring situations.

C. All boxes shall be of the size and shape required by NFPA 70 for their respective locations.

D. Boxes shall be of such form and dimensions as to be adapted to the specific use and location, type of device or fixtures to be used, and number and size of conductors and arrangement, size

and number of conduits connecting thereto.

E. Handy boxes shall not be used.

F. Where a box is used as the sole support for a ceiling paddle fan, the box must be listed for this purpose and the weight of the fan.

G. 4” x 4” boxes and 4-11/16” x 4-11/16” boxes used as junction boxes shall be one piece.

2.2 SHEET METAL OUTLET BOXES ANSI/NEMA OS 1, GALVANIZED STEEL

A. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2” male fixture studs where required.

B. Concrete Ceiling Boxes: Concrete type.

C. Interior flush outlet boxes shall be galvanized steel constructed with stamped knockouts in back and sides, and threaded holes with screws for securing box coverplates or wiring devices. T&B, Steel City, Raco or accepted substitution.

D. Ceiling outlet boxes shall be 4” octagonal or 4” square x 1-1/2” deep or larger as required for number and size of conductors and arrangement, size and number of conduits terminating at them.

E. Switch, wall receptacle, telephone and other recessed wall outlet boxes in drywall shall be 4” square x 1-1/2” deep. For recessing in exposed masonry, provide one-piece 4” square x 1-1/2” deep wall boxes with appropriate 4” square cut tile wall covers Steel City series #52-C-49/52-C-52 or accepted substitution. For recessing in furred-out block walls, provide 4” square box with required extension for block depth and required extension for drywall depth.

2.3 CAST BOXES NEMA FB 1

A. Interior surface outlet boxes and conduit bodies installed from 0” AFF to 90” AFF (including fire alarm device backbox) shall be the heavy cast aluminum or iron with external threaded hubs for power devices and threaded parts for low voltage devices; Appleton, Crouse Hinds or accepted substitution. Trim rings shall also be of one-piece construction.

B. Weatherproof outlet boxes shall be constructed of corrosion-resistant cast metal suited to each application and having threaded conduit hubs, cast metal faceplate with spring-hinged waterproof cap suitably configured, gasket, and corrosion-proof fasteners.

C. Boxes to be Type FD unless otherwise noted on drawings.

D. Freestanding cast boxes are to be type FSY (with flange). Other cast zinc boxes are not acceptable.

E. Bell Boxes are not permitted.

PART 3 - EXECUTION

3.1 GENERAL

A. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

B. Install electrical boxes to maintain headroom and to present neat mechanical appearance.

C. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6” from ceiling access panel or from removable recessed luminaire.

D. Install boxes to preserve fire resistance rating of partitions and other elements.

E. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.

F. Use flush mounting outlet boxes in finished areas.

G. Do not install flush mounting boxes back-to-back in walls; provide minimum 6” separation. Provide minimum 24” separation in acoustic rated walls.

H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

I. Use stamped steel bridges to fasten flush mounting outlet box between studs.

J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

K. Support all outlet boxes from structure with minimum of one 3/8” all-thread rod hangers. Boxes larger than 25 square inches shall be supported with two all-thread rod hangers, minimum.

L. Do not fasten boxes to ceiling support wires.

M. Support boxes independently of conduit.

N. Use gang box where more than one device is mounted together. Do not use sectional box.

O. Use gang box with plaster ring for single device outlets.

P. Use cast outlet box in exterior locations and wet locations.

Q. Comply with applicable portions of the NECA National Electrical Installation Standards.

R. Install outlets in the locations shown on the Drawings; however prior to rough-in, the Owner shall have the right to make slight changes in locations to reflect room furniture layouts.

S. The Contractor shall coordinate his work with that of the General Contractor so that each electrical box is the type suitable for the wall or ceiling construction provided and suitable fireproofing is inbuilt into fire rated walls.

T. The Contractor shall relocate electrical boxes as required so that once installed, electrical devices will be symmetrically located with respect to the room layout.

U. All boxes shall be installed in a flush rigid manner with box lines at perpendicular and parallel angles to finished surfaces. Boxes shall be supported by appropriate hardware selected for the type of surface from which the box shall be supported. For example, provide metal screws for metal, wood screws for wood, and expansion devices for masonry or concrete.

V. For locations exposed to weather or moisture (interior or exterior) provide weatherproof boxes and accessories.

W. As a minimum, provide pull boxes in all raceways over 150’ long. The pull box shall be located near the midpoint of the raceway length.

X. Provide knockout closures to cap unused knockout holes where blanks have been removed, and plugs for unused threaded hubs.

Y. Provide conduit locknuts and bushings of the type and size to suit each respective use and installation.

Z. Boxes and conduit bodies shall be located so that all electrical wiring is accessible.

AA. Avoid using round boxes where conduit must enter box through side of box, which would result in a difficult and insecure connection with a locknut or bushing on the rounded surface.

BB. All flush outlets shall be mounted so that covers and plates will finish flush with finished surfaces without the use of shims, mats or other devices not submitted or accepted for the purpose. Add-a-Depth rings or switch box extension rings (Steel City #SBEX) are not acceptable. Plates shall not support wiring devices. Gang switches with common plate where two or more are indicated in the same location. Wall-mounted devices of different systems (switches, thermostats, etc.) shall be coordinated for symmetry when located near each other on the same wall. Outlets on

each side of walls shall have separate boxes. Through-wall type boxes shall not be permitted. Back-to-back mounting shall not be permitted. Trim rings shall be extended to within 1/8” of finish wall surface.

CC. Outlet boxes mounted in metal stud walls are to be supported to studs with two screws inside of outlet box to a horizontal stud brace between vertical studs, or one side of outlet box supported to stud with opposite side mounted to section of stud or device to prevent movement of outlet box after wall is finished.

DD. All outlet boxes that do not receive devices in this Contract are to have blank plates installed matching wiring device plates.

EE. Mount Height:

1. Height of wall outlets to bottom above finished floors shall be as follows unless specifically noted otherwise, or unless otherwise required by applicable codes including ADA. Verify with the Architectural Drawings and Shop Drawings for installing:

Switches	4'-0" AFF to top
Receptacles	1'-4" AFF to bottom
Lighting Panels	6'-6" AFF to centerline of highest breaker/fuse
Phone outlets	1'-4" AFF to bottom
Intercom Call-in button/handsets	4'-0" AFF to top
Fire Alarm Pull Stations	4'-0" AFF to top
Fire Alarm Strobe Lights	80" AFF to bottom
Thermostats	4'-0" AFF to top
Space Sensors	4'-0" AFF to top

2. Bottoms of outlets above countertops or base cabinets shall be minimum 2” above counter top or backsplash, whichever is highest. Outlets may be raised so that bottom rests on top of concrete block course, but all outlets above counters in same area shall be at same height. It is the responsibility of this Division to secure cabinet drawings and coordinate outlet locations in relation to all cabinets as shown on Architectural Drawings prior to rough-in, regardless of height shown on Division 26 Drawings.

3. Height of wall-mounted fixtures shall be as shown on the Drawings or as required by Architectural Drawings and conditions. Fixture outlet boxes shall be equipped with fixture studs when supporting fixtures.

FF. Special Purpose Outlets:

1. Locate special purpose outlets as indicated on the drawings for the equipment served. Location and type of outlets shall be coordinated with appropriate trades involved. The securing of complete information for proper electrical roughing-in shall be included as work required under this Section of Specifications. Provide plug for each outlet.

3.2 INTERFACE WITH OTHER PRODUCTS

A. Coordinate installation of outlet box for products furnished under all sections of these specifications.

B. Coordinate locations and sizes of required access doors with applicable sections in these specifications.

C. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

D. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.

E. Position outlet boxes to locate luminaires as shown on reflected ceiling plan.

3.3 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material.

B. Install knockout closure in unused box opening.

END OF SECTION

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SECTION 26 05 35 - PULL AND JUNCTION BOXES

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 requirements for pull and junction boxes.

B. Provide and install pull and junction boxes as shown on Drawings or as required by the NEC.

C. Provide and install pull and junction boxes where required for a complete and operating distribution system whether shown on Drawings or not.

D. Where outlet boxes are used for pull and/or junction boxes, they shall meet the requirements of Section 26 05 34 Outlet Boxes.

1.3 REFERENCES

A. ANSI/NEMA FB 1 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

B. ANSI/NEMA OS 1 Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

C. ANSI/NEMA OS 2 Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports

D. ANSI/NFPA 70 National Electrical Code

E. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.5 SUBMITTALS

A. Submit actual shop drawings of all pull boxes showing:
1. Covers.
2. Dimensions - inside and out.
3. Rating of concrete or gauge of metal.
4. Manufacturer.

1.6 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations and mounting heights of pull and junction boxes.

1.7 PROJECT CONDITIONS

A. Verify field measurements are as shown on Drawings.

B. Verify locations of pull and junction boxes prior to rough-in.

C. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose and to maintain required access.

PART 2 - PRODUCTS

2.1 GENERAL

A. Dimensions of pull and junction boxes shall meet dimensions shown on Drawings, or

dimensions required by NEC, whichever is largest.

B. Pull and junction boxes shall meet all requirements of UL and NEC.

C. Small pull boxes (i.e. 4” x 4”) shall meet the requirements of these Specifications for outlet boxes as a minimum.

D. All boxes (above ground) of 100 cubic inches or more shall be constructed of 14 gauge steel with hot dip galvanized coating.

2.2 SHEET METAL BOXES

A. NEMA OS 1, galvanized steel.

B. Box to be fully weatherproof and watertight where installed outside.

2.3 SURFACE-MOUNTED CAST METAL BOX

A. NEMA 250, Type 4, flat-flanged, surface-mounted junction box.

B. Material: Cast aluminum.

C. Cover: Furnish with ground flange, neoprene gasket and stainless steel cover screws.

D. Provide all hubs as required for conduit connections.

E. Bell Boxes are not permitted.

2.4 IN-GROUND PULL BOXES

A. Material: Precast concrete, or composolite.

B. Bottom: Open with 6” of gravel for drainage.

C. Cover: Meet Florida Dept. of Transportation requirements for installed location (pedestrian, heavy traffic, light traffic).

D. Solid sides constructed to facilitate conduit entries.

PART 3 - EXECUTION

3.1 GENERAL

A. Install per NEC.

B. Install electrical boxes as shown on Drawings and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

C. Install electrical boxes to maintain headroom and to present neat mechanical appearance.

D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

E. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6” from ceiling access panel or from removable recessed luminaire.

F. Install boxes to preserve fire resistance rating of partitions and other elements.

G. Align adjacent wall-mounted boxes with each other.

H. Use flush mounting boxes in finished areas.

I. Do not install flush mounting boxes back-to-back in walls; provide minimum 6” separation. Provide minimum 24” separation in acoustic rated walls.

J. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

K. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

L. Pull and junction boxes larger than 25 square inches shall be supported with two 3/8” all-thread rod hangers minimum.

M. Do not fasten boxes to ceiling support wires.

N. Support boxes independently of conduit.

O. Large Pull Boxes:

1. Boxes larger than 100 cubic inches in volume or 12” in any dimension:

a) Interior dry locations per NEC with screw covers.

b) Other locations use hinged enclosure under provisions of Section 26 27 16 Cabinets and Enclosures.

P. Boxes Installed Outdoors: All boxes installed outdoors to be NEMA 4, fully weatherproof and watertight.

3.2 IN-GROUND PULL BOXES

A. Provide and install ground rod in each pull box. Connect #2 copper ground wires (counterpoise) to ground rod, run out pullbox 6” over conduits to next pull box; tie to respective building electrical ground rod at each building.

B. Install pull boxes flush with finished grade. Provide extensions as required.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations and sizes of required access doors with applicable sections in these Specifications.

B. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

3.4 ADJUSTING

A. Install knockout closure in unused box opening.

END OF SECTION

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SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes identification for electrical systems.

B. Provide and install all equipment, labor and material for a complete identification system, including but not limited to:

1. Nameplates and labels.
2. Wire and cable markers.
3. Conduit markers.

1.3 REFERENCES

A. ANSI/NFPA 70 National Electrical Code

B. Americans with Disabilities Act

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Nameplates shall be laminated phenolic plastic, chamfered edges.

1. 120/208 Volt System:
   a) Black front and back, white core, lettering etched through outer covering, white engraved letters on black background.
2. 277/480 Volt System:
   a) Orange with white letters.

B. Letter Size:

1. 1/8” letters for identifying individual equipment and loads.
2. 1/4” letters for identifying grouped equipment and loads.

C. Nameplates shall adequately describe the function of the particular equipment involved. Where nameplates are detailed on the Drawings, inscription and size of letters shall be as shown and shop drawing submitted for acceptance. Nameplates for panelboards, switchboards, motor control centers, disconnects and enclosed breakers shall include the panel designation, voltage and phase of the supply. For example, "Panel A, 120/208V, 3-phase, 4-wire." In addition, provide phenolic label in panel to describe where the panel is fed from and location. For example, "Fed From MDP-1:3:5 Electrical Room #E101 Level 1." Nameplates for equipment listed below shall describe particular equipment name and associated panel/circuit, if applicable. The name of the machine on the nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and pushbutton station nameplates for that machine.

D. The following items shall be equipped with nameplates:

1. All motors, motor starters, motor-control centers, pushbutton stations, control panels, time switches, disconnect switches, transformers, panelboards, circuit breakers (i.e., all 2-pole, 3-pole circuit breakers), contactors or relays in separate enclosures, power receptacles where the nominal voltage between any pair of contacts is greater than 150V, wall switches controlling outlets that are not located within sight of the controlling switch, high voltage boxes and cabinets, large electrical, and electrical systems (Systems Divisions 27, 28), junction and pull boxes (larger than 4-11/16"), terminal cabinets, terminal boards, and equipment racks. Nameplates shall also describe the associated panel and circuit number, if applicable.

E. All electrical system panels, transfer switches, motor control centers, disconnect switches, motor controllers, etc. shall be labeled as per branch, i.e. "Panel ABC Emergency-Life Safety Branch" (similar for emergency legally required standby branch, or emergency optional standby branch).

2.2 WIRE MARKERS

A. Description: Cloth, tape, split sleeve or tubing type wire markers.

B. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.

C. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number indicated on Drawings including neutral conductor.

2. Control Circuits: Control wire number indicated on schematic and interconnection diagrams on shop drawings.

2.3 CONDUIT/JUNCTION BOX COLOR CODE

A. All conduit system junction boxes (except those subject to view in public areas) shall be color coded as listed below:

COLOR CODE FOR JUNCTION BOXES	KRYLON PAINT NUMBER
Fire Alarm	Safety Orange K02410
Normal Power 277/480 volt	Leather Brown K02501
Normal Power 120/208 volt	Glossy Black K01601
Fiber Optics	Safety Purple K01929
Sound System	Safety Yellow S01813
Intercom	True Blue K01910
Computer/Data	Gold K01701
TV	Glossy White K01501
BAS	Cameo White K04129
Security/CCTV	John Deere Green K01817
Telephone	Clover Green K02012
Grounding	Fluorescent Green K03106

B. Conduit (not subject to public view) longer than 20’ shall be painted with above color paint band 20’ on center. Paint band shall be 4" in length, applied around entire conduit. Where conduit is parallel and on conduit racking, the paint bands shall be evenly aligned. Paint shall be neatly applied and uniform. Paint boxes and raceways prior to installation, or tape conduit and surrounding surfaces to avoid overspray. Paint overspray shall be removed.

C. Junction boxes and conduit located in public areas (areas that can be seen by the public) shall be painted to match surface to which it is attached. Provide written request to A/E for interpretation of those public areas which may be in question.

2.4 CONDUIT/JUNCTION BOX MARKER

A. All new and existing junction boxes/cover plates for power, lighting and systems (except those installed in public areas) shall adequately describe its associated panel and circuit reference number(s) within (i.e. ELRW-2, 4, 6), or systems within (i.e. fire alarm, intercom, etc.). Identification shall be neatly written by means of black permanent marker. Paint one-half of cover plate with appropriate color above, and one-half with associated panel/circuit or system as described above. Junction box cover plates located in public areas shall be identified with small phenolic labels securely attached. Label colors to be determined by A/E. Large pull/junction boxes (8" x 8" or larger) shall be color identified by painting the corners of box cover plate with specified colors at 45 degree angles; phenolic labels as specified herein.

B. Identify conduit not installed in public areas with corresponding panel/circuit numbers or corresponding system type as described above. Spacing 20 ft. on center adjacent to color identification bands.

2.5 UNDERGROUND WARNING TAPE

A. Description: Minimum 4” wide plastic tape, detectable type, with suitable warning legend describing buried lines. Systems conduit shall have orange colored tape. Power/lighting conduit shall have red colored tape.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

3.2 APPLICATION

A. Install nameplate parallel to equipment lines.

B. Secure nameplate to equipment front using stainless steel pop rivets.

C. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

D. Nameplate installed inside on dead front cover shall be self-adhesive tape. Do not drill or install screws in dead front.

E. Identify new conduit, junction boxes, and outlet boxes using field painting.

F. Identify new underground conduit using underground warning tape. Install a minimum of one tape per trench at 3” below finished grade. For trenches exceeding 24” in width, provide one tape per 24” of trench width spaced evenly over trench width.

G. Install wire markers at all new connections and terminations, and at existing connections and terminations modified or altered.

END OF SECTION

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SECTION 26 05 73 - POWER SYSTEM STUDY

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 and Division 26 Specification Sections, apply to this section.

1.2 SUMMARY

A. This section includes the requirements for performing and submitting a system study on the complete power system and adjusting all breakers, devices, etc. according to the results of the study to provide a complete and properly coordinated power distribution system.

1.3 REFERENCES AND REGULATORY REQUIREMENTS

A. Conform to the requirements of the following:

1. ANSI/NFPA 70 National Electrical Code

2. Applicable ANSI/IEEE Standards

1.4 DESCRIPTION

A. Provide all labor, materials, and equipment necessary to properly and completely perform a Power System Study for the electrical distribution and control equipment. Submit results in a report.

B. Electrical distribution and control equipment is to include switchboard(s), distribution panelboard(s), branch circuit panelboard(s), and other significant locations throughout the facility/premises.

C. The Contractor shall be responsible for obtaining all required data of all equipment.

D. The Power System Study shall include a coordination and short circuit study for the complete normal power distribution system.

E. The study shall verify adequacy of all equipment implemented under these Specifications and to verify the correct application of circuit protective devices and other system components specified.

F. The study shall address the case when the system is being powered from the normal source.

G. Minimum as well as maximum possible fault conditions shall be covered in the study.

H. Fault conditions of all motors shall be considered.

I. Adjust all breakers, devices, relays, etc. according to the results of the study to provide a complete and properly selective coordinated power distribution system.

1.5 SUBMITTALS

A. A summary of the short circuit analysis shall be submitted at the time shop drawings for all new equipment is submitted for approval.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit copy of study (in separate binder) with Operation and Maintenance Manual.

1.7 QUALITY ASSURANCE

A. Study shall be performed by a Florida Registered Professional Engineer.

PART 2- PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 GENERAL

A. The manufacturer/contractor shall provide data necessary to perform the study. This includes feeder cable sizes, approximate feeder lengths, motor data, all overcurrent protective device data (including branches/main, and Electronic trip settings), and any other information relevant to study.

B. All back-up calculations shall become part of the final report. The calculations shall be in sufficient detail to allow easy review.

3.2 CONTENTS

A. The study shall include representation of the power company’s system, the base quantities selected, impedance source data, calculation methods and tabulations, one-line diagram, impedance diagram, conclusions and recommendations.

B. Short circuit momentary duties shall be calculated on the basis of an assumed bolted 3-phase short circuit at each 480 volt bus, low voltage switchboard bus, switchboard, distribution panelboard, branch circuit panelboard, and other significant locations throughout the system.

C. A protective device time current coordination study shall be included with coordination plots of key and/or limiting devices, tabulated data, rating, and/or settings selected. The study shall present an engineering balance between the competing objectives of protection and continuity of service for the system specified, taking into account the basic factors of sensitivity, selectivity, and speed.

D. Separate plots shall be provided for each mode of “normal” and “stand-by” operation. Maximum fault values shall be shown in each case. Both power sources shown in one plot will not be accepted.

E. Required settings for breakers and ground fault sensors shall be maximized to provide the most effective protection possible whether the system is fed from normal source.

F. Tabulations indicating recommended set points for all protective devices shall be provided. This shall include the normal as well as the emergency source.

3.3 MOTOR CURRENT –TIME CHARACTERISTIC CURVES

A. A complete independent set of current-time characteristic curves for all medium voltage drives indicating coordination between the protective relay and the thermal characteristics of the motor shall be provided.

B. The Contractor shall obtain from the motor supplier, the necessary information to perform the study. Certified curves for “safe time versus current at 100 percent voltage” and “accelerating time versus current at 100 percent voltage” shall become part of the final report.

3.4 TIME-CURRENT CURVE PRESENTATION

A. The coordination plots shall include complete titles, representative one-line diagrams, legends, associated power company’s relay or system characteristics, significant motor staring characteristics, complete parameters for power and substation transformers, and complete operating bands for low-voltage circuit breaker trip devices.

B. The coordination plots shall define the types of protective devices selected, together with the proposed coil taps, time-dial settings and pick-up settings required.

C. The short-time region shall indicate the magnetizing in-rush, and ANSI withstand transformer parameters, the low-voltage circuit breaker instantaneous trip devices, fuse manufacturing tolerance bands, and significant symmetrical and asymmetrical fault currents.

D. Each primary protective device required for a delta-to-wye connected transformer shall be selected so that the characteristic or operating band is within the transformer parameters; which,

where feasible shall include a parameter equivalent to 58 percent of the ANSI withstand point to afford protection for secondary line-to-ground faults.

E. Low-voltage power circuit breakers shall be separated from each other and the associated primary protective device, where feasible, by a 16 percent current margin for coordination and protection in the event of secondary line-to-line faults.

F. Protective relays shall be separated, where feasible, by a 0.3-second time margin when the maximum three-phase fault flows, to assure proper selectivity.

3.5 SUBMITTAL

A. The study shall be submitted in a bound 8-1/2” x 11” size report; three copies.

B. The final selection of all protective devices shall be based on preliminary draft of the coordination study, which shall be submitted with the equipment shop drawings for review.

C. The completed study shall be submitted to and accepted prior to shipping of any equipment.

D. All protective devices shall be adjusted, tested, and calibrated in the field prior to energizing the equipment, per the settings listed in the accepted study. This work shall be performed by the manufacturer prior to final acceptance by Owner.

E. All protective devices shall be calibrated and tested as recommended by and under the supervision of the equipment manufacturer’s representative.

END OF SECTION

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SECTION 26 08 13 - TESTS AND PERFORMANCE VERIFICATION OF ELECTRICAL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section pertains to the furnishing of all labor, materials, equipment and services necessary to test and prove performance of the electrical system.

B. Operate system for a three day period. Do performance verification work as required to show that the system is operating correctly in accordance with design. Supply instruments required to read data. Adjust system to operate at the required performance levels.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TESTS

A. System:

1. General: After installation of all conductors and before final acceptance, make required tests to determine proper functioning of all circuits. Furnish all necessary instruments required to make tests and correct any deficiencies found. Prior to energizing, circuits shall be "rung-out" to verify opens, intentional and non-intentional grounds, continuity and detect short circuits by accepted constant megger.

2. Procedure:

a) All wires in conduit that are shorted or unintentionally grounded shall be replaced.

b) Insulation resistance of all feeder conductors and all conductors AWG #1 and larger shall be tested. Each conductor shall have its insulation resistance tested after the installation is completed and all splices, taps, and connections are made, except connection to source and point of final termination at distribution or utilization equipment.

c) Insulation resistance of conductors that are to operate at 600 volts or less shall be tested by using AVO Biddle (or accepted equal) megger at not less than 1000 volts dc. Resistance shall be measured from conductor to conduit (ground). Testing methodology shall conform to short-time or spot-reading procedural recommendations of AVO Biddle Instruments for specific megger being used. Acceptable insulation resistance of conductors rated at 600 volts shall not be less than 1 megohm.

d) Conductors that do not satisfy test requirements of paragraph c) above, shall be removed, replaced, and testing repeated on new cable at no additional cost to the Owner. All tests shall be performed by licensed electrician trained in the use of test instruments. Contractor shall furnish all instruments and personnel required for tests, shall tabulate readings observed, complete Conductor Insulation Resistance Test Form (see Section 26 01 00 Operation and Maintenance Manuals) and submit five copies to Engineer for acceptance. Test shall be witnessed by Owner’s Representative and Engineer (if so desired). Final acceptance data is to be submitted in O & M Manual.

e) Test reports shall identify each feeder conductor tested, date, time, and result of test, weather conditions and range, test voltage, and serial number of the megger

instrument used. Any conductor or splice that is found defective shall be promptly removed and replaced and an additional test shall be performed.

f) Observe all safety instructions set by testing equipment manufacturer. Application of voltage testing involves risk of electric shock and sparking.

3. Take readings of voltage and amperage at building main disconnect switch and at main for each panel, at primary and secondary side of each transformer, and at the end of the longest branch circuit at each panel. The above readings shall be taken 1) "no load" conditions and 2) "full load" conditions with all equipment using electricity. Tabulate readings, complete Tabulated Data Voltage and Amperage Readings form (see Section 26 01 00 Operation and Maintenance Manuals) and submit five copies to the Engineer for acceptance. Final accepted data is to be submitted in O & M Manual.

B. Motors:

1. Test run each motor via motor's control unit in both manual mode and automatic mode. Verify proper operation, voltage and rotation.

C. Grounds:

1. Test each raceway for raceway continuity as called for in Section 26 05 26 Grounding and Bonding.

2. Test each grounding system used in the project as called for in Section 26 05 26 Grounding and Bonding.

3. Submit Ground Test Information form (see Section 26 01 00 Operation and Maintenance Manuals) for every grounding system in the project, including but not limited to, each ground rod installation, each water pipe and ground installation (test water pipe to ground and test water pipe to building service equipment), and each building steel ground connection (test building steel to ground and test building steel to building service equipment).

4. Grounding resistance shall be as called for in Section 26 05 26 Grounding and Bonding.

5. Testing shall be 3-point method in accordance with IEEE recommended practice.

6. Transformer grounding.

D. Communications:

1. See specific sections of these Specifications for further requirements.

E. Service Ground Fault Protection System:

1. See specific sections of these Specifications for further requirements.

F. Ground Fault System:

1. The ground fault protection system shall be performance tested when first installed on site. The test shall be conducted in accordance with instructions that shall be provided with the equipment. A written record of this test shall be made and shall be provided to the Authority Having Jurisdiction and to the Engineer of Record.

END OF SECTION

SECTION 26 09 23 - OCCUPANCY SENSORS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Contractor's work to include all labor, materials, tools, appliances, control hardware, sensors, wire, junction boxes and equipment necessary for and incidental to the delivery, installation and furnishing of a completely operational occupancy sensor lighting control system as described herein.

B. Contractor/Supplier shall examine all general specification provisions and drawings for related electrical work required as work under Division 26.

C. The Occupancy Sensor System shall sense the presence of human activity within the desired space and fully control the “On” / “Off” function of the lights.

D. Sensing technologies shall be completely passive meaning that they will not emit any radiation that is known to interfere with certain types of hearing aides, or electronic devices such as electronic white board readers. Acceptable programmable shall be Passive Infrared (PIR), and/or PIR/Microphonic Passive Dual Technology (PDT). Ultrasonic or Microwave based sensing technologies shall not be accepted.

E. Time Delay settings shall be factory set at 10 minutes, and shall not be field adjusted unless specifically instructed by Engineer. This delay selection is based on lamp life vs. energy savings and sensor performance. Automatic adjustments to this delay period by the sensor shall not be permitted.

F. In high humidity or cold environments, the sensors must be conformably coated and rated for condensing humidity and -40 degree Fahrenheit (and Celsius) operation.

G. Installer, in accordance with manufacturer’s recommendation, shall determine final sensor location. All sensors shall have non-adjustable factory calibrated sensitivity for maximum performance. Time Delay and Photocell field adjustments shall be provided as needed.

H. The installer shall be responsible for a complete and functional system in accordance with all applicable local and national codes.

1.3 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.4 DESIGN REQUIREMENTS

A. The objective of this section is to ensure the proper installation of the occupancy sensor based lighting control system so that lighting is turned off automatically after reasonable time delay when a room or area is vacated by the last person to occupy said room or area.

B. The occupancy sensor based lighting control shall accommodate all conditions of space utilization and all irregular work hours and habits.

1.5 EQUIPMENT QUALIFICATION

A. All components shall be UL listed and offer a five year warranty.

1.6 SUBMITTALS

A. Shop Drawings:

1. Submit shop drawings showing actual field conditions for this project’s installation.

B. Product Data:

1. Submit data sheets on sensors, control units and all junction boxes and mounting accessories, including all wiring diagrams (standard).

C. Submit manufacturer's installation instructions.

1.7 PROJECT RECORD DOCUMENTS

A. Submit record documents to accurately record actual location of each sensor and control unit.

B. Revise diagrams included in Drawings to reflect actual control device connections.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit instructions for operation, use, and adjustment of system.

B. Submit recommended preventive maintenance procedures and materials.

C. Submit parts list.

1.9 APPROVED MANUFACTURER AND SUBSTITUTIONS

A. Approved manufacturer shall be Sensor Switch, Inc. (800) 727-7483 www.sensorswitch.com.

B. Refer to 01 25 00 Substitution Procedures.

C. An AutoCAD drawing of the facility showing coverage patterns and technical data must be provided with substitution request. All substitutions must clearly identify any and all exceptions to the specifications with a detailed explanation as to the exception. If substitution is approved, the Contractor shall bear the responsibility of a fully functional system to the Owner’s and Engineer’s satisfaction.

D. Product must be manufactured in the USA and be warranted for five years.

1.10 WARRANTY

A. Contractor shall warrant all equipment furnished in accordance with this specification to be undamaged, free of defects in materials and workmanship, and in conformance with the specifications.

B. The supplier’s obligation shall include repair or replacement and testing of all parts of equipment found to be damaged, defective or non-conforming and returned to the supplier. This shall be at no cost to the Owner.

C. Warranty on sensor and control units will be for a period of five years.

D. The warranty shall commence upon the Owner's acceptance of the project.

E. Warranty on labor shall be for a minimum period of one year.

1.11 INSTRUCTION TO OWNER

A. The Contractor shall provide, at the Owner's facility, the training necessary to familiarize the Owner's personnel with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.

PART 2 - PRODUCTS

2.1 WALL SWITCH SENSORS – SMALL AREAS

A. Sensor shall recess into single gang switch box and fit a standard Decora opening.

B. Sensor must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.

C. Sensor shall use PIR sensing incorporating a nominal 1/2” focal length lens viewing 9” above and below horizontal view pattern measured at 10’.

D. Sensor shall have optional features for photocell/daylight override, vandal resistant lens, and no switch as specified.

E. In areas with inboard/outboard switching, sensor shall provide two dedicated relays and override switches. Each relay shall have independent programmable time delays.

F. In areas with obstructions to the occupant’s workspace, sensor shall utilize programmable dual technology PIR/Microphonic sensing.

G. All models shall have “Reduced Turn On.” This is a field programmable function for problematic areas with unforeseen reflective surfaces. False turn on shall be eliminated with this feature.

H. Sensor shall be the following Sensor Switch model numbers. Device color and optional features as specified herein or shown on Drawings.

1. WSD (PIR)
2. WSD-2P (PIR inboard/outboard)
3. WSD-PDT (PIR/Microphonic)
4. WSD-PDT-2P (PIR/Microphonic inboard/outboard)
5. WSD-SA (PIR Semi-Automatic)
6. WSD-PDT-SA (PIR/Microphonic Semi-Automatic)

2.2 WALL SWITCH SENSORS – LARGE AREAS

A. Sensor shall surface mount to single gang switch box.

B. Sensor shall use PIR sensing incorporating a nominal 1” focal length lens viewing 9” above and below horizontal view pattern measured at 20’.

C. Sensor shall have optional feature for photocell/daylight override.

D. In areas with inboard/outboard switching or two circuits, sensor shall provide two dedicated relays and override switches.

E. In areas with obstructions to the occupant’s workspace, sensor shall utilize dual technology PIR/Microphonic sensing.

F. Sensor shall be the following Sensor Switch model numbers. Device color and optional features as specified.

1. LWS (PIR)
2. LWS-2P (PIR inboard/outboard or two circuits)
3. LWS-PDT (PIR/Microphonic)
4. LWS-PDT-2P (PIR/Microphonic inboard/outboard or two circuits

2.3 LOW VOLTAGE SENSORS

A. Sensors shall operate on a Class 2, 3-conductor system. Sensors shall operate on 12 to 24 VAC or VDC and consume no more than 5 milliamps so that up to 14 sensors may be connected to a single power pack.

B. 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.

C. In areas with clear line of site view of the workspace, sensors shall use PIR detection. In areas with obstructions, sensors shall use PIR/Microphonic detection.

D. Specific sensors shall have optional feature for photocell/daylight override, and/or Low Temperature/High Humidity environments.

E. Sensors shall be the following Sensor Switch model numbers.

1. CM-9 (PIR Ceiling)
2. CM-PDT (PIR/Microphonic Ceiling)
3. CM-10 (PIR Ceiling-Extended Range)
4. CM-PDT-10 (PIR/Microphonic Ceiling-Extended Range)
5. WV-PDT (PIR/Microphonic Wall Mount)
6. HW-13 (PIR Hallway)
7. HM-10 (PIR High Bay Aisle Way)
8. CM-6 (PIR High Bay)

2.4 POWER PACKS

A. Power packs shall accept 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 1/2” 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 model numbers.

1. PP-20 (Single Pole)
2. PP-20-2P (Two Pole)
3. SP-20 (Slave Pack)

2.5 LINE VOLTAGE SENSORS

A. Sensors shall be self-contained and accept Class 1 wiring directly without the use of a power pack.

B. In areas with clear line of site view of the workspace, sensors shall use PIR detection. In areas with obstructions, sensors shall use PIR/Microphonic detection.

C. Multiple sensors controlling the same load shall be wired in parallel.

D. Wall mounted sensors must be installed at 7’ to 8’ above the floor. Single and two circuit units shall be available.

E. 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.

F. Specific sensors shall have optional feature for Low Temperature/High Humidity environments.

G. Sensors shall be the following Sensor Switch model numbers.

1. CMR-9 & CMR-9-2P (PIR Ceiling Mount- single and two pole)
2. CMR-PDT & CMR-PDT-2P (PIR/Microphonic Ceiling Mount- single and two pole)
3. CMR-10 & CMR-10-2P (PIR Ceiling Mount Extended Range - single and two pole)
4. CMR-PDT-10 & CMR-PDT-10-2P (PIR/Microphonic Ceiling Mount Extended Range - single and two pole)
5. WVR-16 & WVR-16-2P (PIR Wall Mount single and two pole)
6. WVR-PDT & WVR-PDT-2P (PIR/Microphonic Wall Mount single and two pole)
7. HMR-10 (PIR High Bay Aisle Way)
8. CMR-6 & CMR-6-SH (High Bay Ceiling)

2.6 WIRING

A. Between sensors and controls, units shall be a minimum three conductors, 18 AWG, stranded UL Classified, PVC insulated or TEFLON jacketed cable accepted for use in plenums.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and equipment in accordance with manufacturer's instructions.

B. It shall be the Contractor's responsibility with the supplier’s assistance to locate and aim sensory in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas.

C. Rooms shall have 90 to 100 percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within in the room(s).

D. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only rooms which are to be provided with sensors.

E. The Contractor shall provide additional sensors if required to properly and completely cover the respective room.

F. Proper judgment must be exercised in executing the work so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components

END OF SECTION

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SECTION 26 22 13 - DRY TYPE TRANSFORMERS

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. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for dry type transformers.

1.3 REFERENCES

A. NECA National Electrical Contractors Association

1.4 REGULATORY REQUIREMENTS

A. NFPA 70 National Electrical Code

B. IEEE C57.12.91 Test Code for Dry-Type Distribution and Power Transformers.

C. Furnish products listed and classified by UL as suitable for purpose specified and shown.

D. NEMA ST 1 Specialty Transformers

E. NEMA ST 20 Dry Type Transformers for General Applications

F. UL 15761 Dry-Type General Purpose and Power Transformers

1.5 SUBMITTALS

A. Submit Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, nameplate data, voltage, kVA, impedance ratings, clearances and characteristics, tap configurations, insulation system type, and rated temperature rise.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Sound-Level Test Reports: certified copies of manufacturer’s sound-level tests applicable to equipment for this project.

D. Source quality control test reports for transformers under provisions of Section 26 08 13 Tests and Performance Verification of Electrical Systems.

1. Provide production testing of each unit in accordance with NEMA ST 20.

E. Field quality-control test reports.

F. Operation and Maintenance Data for transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALIFICATIONS

A. Installer Qualifications: Performs work in accordance with NECA National Electrical Installation Standards.

B. Manufacturer’s Qualifications: Company specializing in manufacturing products specified in this section with minimum ten years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and protect products at site.

B. Deliver transformers individually wrapped for protection and mounted on shipping skids.

C. Accept transformers on site. Inspect for damage.

D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.8 WARRANTY

A. Ten years minimum unlimited repair or replacement.

PART 2 - PRODUCTS

2.1 TWO-WINDING TRANSFORMERS

A. Manufacturers:

1. Same manufacturer as panelboards utilized on project.

B. Description: NEMA ST 20, factory-assembled, air cooled dry type transformers, ratings as indicated.

C. Insulation system and average winding temperature rise for rated kVA as follows:

1. 1 - 15 kVA: Class 185 with 115 degrees C rise.
2. 16 - 500 kVA: Class 220 with 150 degrees C rise.

D. Case temperature: Do not exceed 35 degrees C rise above ambient at warmest point.

E. Winding Taps:

1. Transformers Less Than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.

2. Transformers 15 kVA and Larger: NEMA ST 20.

F. Sound Levels: NEMA ST 20.

G. Basic Impulse Level: 10 kV.

H. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

I. Mounting: Suitable for wall, floor, or trapeze mounting, except transformers larger than 75 kVA, suitable for floor or trapeze mounting.

J. Coil Conductors: Continuous windings with terminations brazed or welded.

K. Transformer windings shall be continuous wound copper (98 percent conductivity) construction.

L. Enclosure: NEMA ST 20; Type 1 or Type 3R ventilated as indicated or required by location. Provide lifting eyes or brackets.

1. Finish Color: Gray.

M. Isolate core and coil from enclosure using vibration-absorbing mounts.

N. Nameplate: Include transformer connection data.

2.2 SOURCE QUALITY CONTROL

A. Provide testing of transformers under provisions of Section 26 08 13 Tests and Performance

Verification of Electrical Systems.

B. Provide production testing of each unit in accordance with NEMA ST 20.

2.3 K RATED TRANSFORMERS

A. Provide double size neutral terminals for additional neutral cables.

B. For K rating of transformers, refer to Power Riser Diagram in the Contract Documents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify site condition.

B. Verify that surfaces are suitable for installing transformer supports.

3.2 PREPARATION

A. Provide concrete pad sized minimum of 3” or larger on all sides of the transformer.

3.3 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Set transformer plumb and level.

C. Use flexible conduit, under the provisions of Section 26 05 33 Conduit, 1’ minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

D. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

E. Provide grounding and bonding in accordance with Section 26 05 26 Grounding and Bonding.

F. Ground per NEC 250.26 and all applicable codes per Authority Having Jurisdiction.

3.4 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed.

B. Check for damage and tight connections prior to energizing transformer.

C. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION

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SECTION 26 24 16 - PANELBOARDS

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. Provide all labor, materials, and equipment necessary to properly and completely install panelboards as scheduled on the Drawings and as required by this Section.

1.3 REFERENCES

A. NECA National Electrical Installation Standards
B. NEMA PB 1 Panelboards
C. NEMA PB 1.1 General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
D. NFPA 70 National Electrical Code
E. UL 50 Enclosures for Electrical Equipment
F. UL 67 Panelboards
G. UL 489 Molded Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by UL as suitable for purpose specified and indicated.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with NECA National Electrical Installation Standards.

B. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum ten years experience.

1.6 SUBMITTALS

A. Product data shall be submitted on:

1. Panel.
2. Cabinet.
3. Bus.
4. Dimensions.
5. Construction.

B. Shop drawings shall be submitted for every panel on this project. Clearly indicate the following information:

1. UL label.
2. Each circuit breaker amperage rating, circuit number and position/location in panel.
3. Electrical characteristics of panel.
4. Mains rating.
5. Main device rating.
6. Mounting.
7. Dimension, width, depth, height.
8. Bus material.
9. Interrupting capacity of minimum rated breaker.
10. Panel type.

11. Series AIC rating with upstream breakers.

1.7 PROJECT RECORD DOCUMENTS

A. Submit record documents to record actual locations of products; indicate actual branch circuit arrangement.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit Maintenance Data: Include spare parts data listing, source and current prices of replacement parts and supplies, and recommended maintenance procedures and intervals.

1.9 FIELD MEASUREMENTS

A. Verify that field measurements are as instructed by manufacturer.

1.10 MAINTENANCE MATERIALS

A. Provide two of each panelboard key.

1.11 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle panelboards and enclosures carefully to prevent damage.

B. Store equipment indoors and protect from weather.

C. Deliver tubs and internal assemblies sufficiently in advance of installation period as necessary to prevent delay of work. This time shall be established by a CPM provided by the Contractor and accepted by the supervising authorities.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Square D.

B. Manufacturers (including accepted substitutions) must provide equipment equal to or superior than the basis of design used on this project.

1. Panels or circuit breakers with an AIC rating less than that shown on the Drawings will not be approved.

2. Where basis of design panelboard can accept a certain type, frame, and/or AIC rated breaker, then the accepted substitution manufacturer must also be able to accept all equal breaker type, frame, and/or AIC rating.

2.2 GENERAL

A. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1, circuit breaker type, dead front UL 67.

B. Panelboard Bus: Copper ratings as indicated. Provide copper ground bus in each panelboard. Provide isolated full size neutral bus where neutral is applicable. Provide non-linear load panelboards as specified on Drawings. Non-linear panelboards shall have 200 percent rated neutral busbar.

C. Short Circuit Rating:

1. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical for 240 volt panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards. Bus shall be braced for minimum capacity equal to or greater than the lowest breaker symmetrical interrupting capacity. Minimum short circuit rating shall be increased to meet the following requirements:

a) Individual CB AIC rating shown on panel schedules indicate lowest AIC rating allowed for individual circuit breaker in panel.

b) Panel series AIC rating shown is the required rating of panel and its circuit breakers based on series rating of individual panel circuit breakers with panel main circuit breaker or upstream feeder breaker.

c) Circuit breaker types are not shown or called for. The Contractor must provide breakers in panel or feeder breakers in upstream breakers to comply with the required AIC ratings given, including providing current limiting breakers where required to achieve all ratings given.

2. Short Circuit Rating Label:

a) Panelboards shall be labeled with a UL short-circuit rating.

b) When series ratings are applied with integral or remote upstream devices, a label or manual shall be provided. It shall state the conditions of the UL series ratings including:

1. Size and type of upstream device.

2. Branch devices that can be used.

3. UL series short-circuit rating.

D. Enclosure:

1. Enclosures shall be at least 20” wide made from galvanized steel. Provide minimum gutter space in accordance with the National Electrical Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. At least four interior mounting studs with adjustable nuts shall be provided.

2. Enclosures shall be provided with blank ends.

3. Where indicated on the Drawings, branch circuit panelboards shall be column width type.

4. Regulatory requirements:

a) NEMA PB 1, Type 1, Type 3R, or Type 4X as indicated on Drawings. Use only Type 3R or Type 4X for units to be installed outdoors. Use only Type 4X in interior wet locations and designated wash-down areas. For the purposes of this specification, a wash-down area is defined as any area that is directly washed or rinsed with any form of water hose.

5. Cabinet Box: 6” deep, 20” wide minimum, constructed of code gauge steel, galvanized or bonderized to prevent rust.

E. Cabinet Front: Flush or surface (as indicated on Drawings) cabinet front with concealed trim clamps, concealed hinge, and flush lock all keyed alike. Finish in manufacturer's standard baked enamel finish for interior panels. Exterior panels to be painted with rust inhibit primer painted over on all surfaces with epoxy paint.

F. Panels and breakers shall be rated for voltage and class of service to which applied.

G. Spaces:

1. Space provisions or spaces for future breakers shall be located at the bottom of the panel and be fully bused complete with all necessary mounting hardware less the breaker.

H. Provide lugs as required for conductors being connected to panelboard lugs, circuit breakers, etc.

2.3 MAINS

A. Provide main lug only (MLO) or main circuit breaker (MCB) as noted on Drawings either by riser diagram or by schedule. Where conflict exists, provide MCB.

B. Regardless of what is shown on Drawings, provide the following minimum requirements:

1. Main circuit breaker on each panel serving building main if required by applicable codes.

2. Main circuit breaker on each panel fed directly from a transformer (unless disconnect with overcurrent devices is installed in feeder between transformer and panel).

C. Provide lugs as required for conductors being connected to panelboard lugs, circuit breakers, etc.

D. Main circuit breaker is not to be mounted as branch breaker or subfeed breaker.

2.4 CIRCUIT BREAKERS

A. General

1. Molded Case Circuit Breakers: Plug-in type for 250V or less, bolt-on type for over 250V, thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers.

2. Current Limiting Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

B. Main Breakers:

1. Main breakers shall be individually mounted separate from branch breakers.

2. Covered by a metal plate, except for operating handle.

3. Connection from the load's side to the panel bus shall be bus bar. Insulated wire not permitted.

C. Branch Breakers:

1. Thermal-magnetic, molded case, with inverse time-current overload and instantaneous magnetic tripping, unless otherwise shown. Breakers shall be calibrated for 40 degrees C or shall be ambient compensating.

2. Quick-make, quick-break, with tripped indication clearly shown by breaker handle taking a position between ON and OFF.

3. Single pole 15 and 20 ampere circuit breakers shall be rated for switching duty and shall be labeled as "SWD."

4. AIC rating shall be as called for under “2.2 General.”

5. Ground Fault Circuit Interrupters (GFCI):

a) Provide UL Class (5 milliamp sensitivity) ground fault circuit protection on 120 VAC branch circuits for exterior location receptacles and for interior locations where required by NEC. (These may not be indicated on Panel Schedule.) This protection shall be an integral part of the branch circuit breaker, which also provides overload, and short circuit protection for branch circuit wiring. Tripping of a branch circuit breaker containing ground fault circuit interruption shall not disturb the feeder circuit to the panelboard. Provide separate neutral for circuits on GFCI breakers whether indicated on Drawings or otherwise.

6. Breakers feeding heating and air-conditioning equipment shall be rated HACR type breaker.

7. Breakers feeding high intensity discharge lamps shall be HID rated.

D. All breakers are to have lugs sized to match conductors called for on Drawings.

2.5 SERVICE ENTRANCE EQUIPMENT

A. Panelboards used as service entrance equipment shall be listed and labeled by UL for use as service equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1. Install all panelboards and panelboard enclosures in accordance with the manufacturer's written instructions, NECA National Electrical Installation Standards, the applicable requirements of the National Electrical Code, and recognized industry practices.

B. Install panelboards plumb. Install recessed panelboards flush with wall finishes. Provide supports in accordance with Section 26 05 29 Hangers and Supports.

C. Height: 6’ to top of panelboard; install panelboards taller than 6’ with bottom no more than 4” above housekeeping curb.

D. Provide filler plates for unused spaces in panelboards.

E. Provide typed circuit directory for each branch circuit panelboard. Mount a typewritten directory showing the actual circuit numbers, type of load and room names on inside of door. Room names shall be actual names or numbers used, not necessarily shown on the Drawings. Progress Drawings shall show same arrangements as the directory. Revise directory to reflect circuiting changes required to balance phase loads.

F. Provide engraved plastic nameplates under the provisions of Section 26 05 53 Identification for Electrical Systems.

G. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Minimum spare conduits: 4 empty 1”. Identify each as “SPARE”.

H. Proper working clearances shall be maintained at every panelboard location. The working space in front of a panelboard shall be as a minimum, 30” wide extending 3’, 3.5’, or 4’, per NEC 110.26, out perpendicular to the panelboard.

I. All enclosures shall be firmly anchored to walls and supporting structures (where used) using appropriate hardware. Provide supporting (unistrut type) channels on walls constructed of gypsum board or where otherwise necessary to provide a mechanically secure and permanent installation. Enclosures shall be installed so that the top is 6’-6” above finished floor. Where the size of the enclosure is such that the top cannot be installed at 6’-6”, the top of the enclosure shall be kept as low as possible.

J. Clean the interior of each panelboard before installing conductors. At all times, keep the interior trim and exterior surfaces of the panelboard free of rust and debris. Repaint finishes if necessary.

K. Coordinate all raceways and conductors with their respective panelboards so that all connections and conductors routing present an orderly appearance. Conductors in the panelboards shall be laced and arranged in orderly manner.

L. Collect all keys upon delivery of panelboard. Store keys on one ring to be kept by project superintendent. Forward key ring with keys to Owner upon substantial completion.

M. Provide a separate neutral conductor for each GFI breaker. These shall not be combined to serve more than one circuit, even where on different phases. Increase plan indications of conductors for neutral wires required, as necessary.

3.2 IDENTIFICATION

A. Refer to Section 26 05 53 Identification for Electrical Systems for products and content.

B. Provide engraved plastic nameplates under the provisions of Section 26 05 53 Identification for Electrical Systems.

C. Nameplate shall state panel name and voltage of this panel, name of panel that feeds this respective panel, and UL short-circuit rating of this panel.

D. Provide labels and identification as required by the NEC.

E. All circuit identifications and directories shall be checked to verify accuracy of the description of the load and/or equipment being fed.

3.3 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed.

B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

C. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

D. Feeder conductors shall be checked by accepted means to establish the absence of shorts to ground, insulation value, etc., and the result recorded and submitted to the Engineer.

E. All circuits shall be operated to establish a good working order and checked for shorts.

F. All panel directory circuit numbers shall be checked to verify accuracy of the number.

G. Where and when requested by Engineer provide:

1. Inspection of equipment by authorized equipment manufacturer technician complete with submittal of statement of findings by technician, and providing any adjustments deemed necessary for a complete and operating system.

2. Ground, voltage, and/or load readings complete with submittal on legible form with applicable data.

END OF SECTION

SECTION 26 24 17 - DISTRIBUTION PANELBOARDS

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. Factory-assembled, metal-enclosed panelboard for distribution and control of power from incoming line terminals to outgoing feeder terminals, installed and tested in place.

B. Distribution panelboard shall include all protective devices and equipment as listed on Drawings or as included in these Specifications with necessary interconnections, instrumentation.

1.3 REFERENCES AND REGULATORY REQUIREMENTS

A. ANSI/NFPA 70 National Electrical Code

B. NEMA KS 1 Enclosed and Miscellaneous Distribution Equipment Switches (60 Volts Maximum)

C. NEMA PB 2 Deadfront Distribution Switchboards

D. NEMA PB 2.1 Proper Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less

E. UL 67 Panelboards

F. UL 50 Enclosures for Electrical Equipment

G. UL 489 Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.5 SUBMITTALS

A. Shop Drawings:

1. Shop drawings shall clearly indicate:

a) Front and side views of enclosures with overall dimensions shown.

b) Conduit entrance locations and requirements.

c) Nameplate legends.

d) Size and number of bus bars per phase, neutral, and ground.

e) Frame sizes and interrupting capacity of each breaker, and total assembly.

f) Horsepower ratings at rated voltage of fused switches and/or breakers.

g) Type of labels and labeling for every device and what it feeds.

h) Nameplate on main panelboard only giving name of project, Architect, Engineer and Contractor.

i) Bus bar size, arrangement and spacing.

B. Product Data: Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.

C. Test Reports: Indicate results of factory production tests.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under “Regulatory Requirements.” Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 10 years experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and protect products at the site.

B. Deliver in sections as required to fit equipment through doors, individually wrapped for protection and mounted on shipping skids.

C. Accept switchboards on site. Inspect for damage.

D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Conform to NEMA PB 2 service conditions during and after installation of switchboards.

1.10 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated and comply with instructions by manufacturer.

1.11 MAINTENANCE MATERIALS

A. Provide two of each key (where applicable).

B. Provide two fuse pullers (where applicable).

PART 2 - PRODUCTS

2.1 GENERAL

A. Panelboards with circuit breaker, or fusible switch, branch protective devices shall comply with NEMA PB 2 as a minimum requirement. Panelboards shall be NEMA I and shall meet Underwriters Laboratories enclosure requirements for service conditions.

B. Each cubicle shall have UL label affixed, unless special construction prohibits and no labeling or listing is available.

C. See Drawings for acceptable manufacturers. Basis of design is Square D.

D. Short-Circuit Rating Label

1. Minimum integrated short circuit rating; 10,000 amperes rms symmetrical for 240 volt, 14,000 amperes rms symmetrical for 480 volt. Bus shall be braced for minimum capacity equal to or greater than the lowest breaker symmetrical interrupting capacity.

Minimum short circuit rating shall be increased to meet the following requirements:

a) Individual circuit breaker AIC rating shown on panel schedule indicates lowest AIC rating allowed for individual circuit breaker in panel.

b) Panel series AIC rating shown is the required rating of panel and its circuit breakers based on series rating of individual panel circuit breakers with panel main circuit breaker or upstream feeder breaker.

c) Circuit breaker types are not shown or called for. The Contractor must provide breakers in panel or feeder breakers in upstream breakers to comply with the required AIC ratings given, including providing current limiting breakers where required to achieve all ratings given.

E. When series ratings are applied with integral or remote upstream devices, a label or manual shall be provided. It shall state the conditions of the UL series ratings including:

1. Size and type of upstream device.

2. Branch devices that can be used.

3. UL series short-circuit rating.

F. Provide lugs on bus, distribution panelboard and circuit breakers as required to match conductors being connected/terminated.

2.2 MANUFACTURERS

A. Basis of Design: Square D

B. Manufacturers (including accepted substitutions) must provide equipment equal to or superior than the basis of design used on this project.

2.3 DISTRIBUTION PANELBOARDS

A. Description: NEMA PB 2 with electrical ratings and configurations as indicated.

B. Main Section Devices: Panel mounted.

C. Distribution Section Devices: Panel mounted.

D. Bus Material: Copper standard size.

E. Bus Connections: Bolted, accessible from front for maintenance.

F. Ground Bus: Extend length of board.

G. Molded Case Circuit Breakers: Integral thermal and instantaneous magnetic trip in each pole. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

H. Current Limiting Molded Case Circuit Breakers: Molded case circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 rms amperes symmetrical let-through current and energy level less than permitted for same size Class RK-5 fuse.

I. Solid-State Molded Case Circuit Breakers: Provide with electronic sensing, timing and tripping circuits for adjustable current settings; ground fault trip; instantaneous trip; and adjustable short time trip. Provide ground fault sensing integral with circuit breaker.

J. Line and Load Terminations: Accessible from the front only of the switchboard, suitable for the conductor materials and sizes indicated.

K. Ground Fault Sensor: (Where called for on Drawings). Zero sequence or ground return type.

L. Ground Fault Relay: (Where called for on Drawings). Adjustable ground fault sensitivity from

200 to 1200 amperes, time delay adjustable from 0 to 15 seconds. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches.

M. Future Provisions: Fully equip spaces for future devices with busing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.

N. Enclosures:

1. Type 1 General Purpose for interior locations
2. Type 2 Raintight for exterior locations.
3. Align sections at front and rear.
4. Finish:
   a) Interior: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
   b) Exterior: Coat interior and exterior of enclosure with rust inhibiting primer and paint over with epoxy paint
5. Enclosures shall be at least 20” wide made from galvanized steel. Provide minimum gutter space in accordance with the National Electrical Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. At least four interior mounting studs with adjustable nuts shall be provided.
6. Enclosures shall be provided with blank ends.
7. Where indicated on the Drawings, branch circuit panelboards shall be column width type.

O. Breakers

1. All breakers are to have lugs sized to match conductors called for on Drawings.
2. Main circuit breaker is not to be mounted as branch breaker or subfeed breaker.
3. Breakers feeding heating and air conditioning equipment shall be rated HACR type breaker.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surface is suitable for distribution panelboard installation.

3.2 PREPARATION

A. Provide concrete housekeeping pad.

3.3 INSTALLATION

A. Install distribution panelboard in locations shown on Drawings in accordance with manufacturer's written instructions and NEMA PB 2.1.

B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

C. Install fuses in each switch (where applicable).

3.4 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 26 08 13 Tests and Performance Verification of Electrical Systems.

B. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

C. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each, at test voltage of 1000 volts; minimum acceptable value for insulation resistance is 2 megohms.

D. Check tightness of accessible bolted bus joints using calibrated torque wrench.

E. Physically test key interlock systems to insure proper function.

3.5 ADJUSTING

A. Adjust all operating mechanisms for free mechanical movement.

B. Tighten bolted bus connections in accordance with manufacturer's instructions.

C. Adjust circuit breaker trip and time delay settings to values as instructed by the Architect/Engineer or (if so directed by A/E) as manufacturer's recommendation.

3.6 CLEANING

A. Touch up scratched or marred surfaces to match original finish.

3.7 LABELING

A. Provide nameplate/label at each protective device.

B. Nameplate shall state panel name, voltage and name of panel that feeds this respective panel.

END OF SECTION

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SECTION 26 27 13 - UTILITY SERVICE ENTRANCE

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. Furnish, install, or otherwise provide all equipment and/or coordination and supervision necessary to furnish a new electrical service to the facility. This shall include all necessary temporary services and connections.

B. Assessments for temporary electrical service shall be paid by the Contractor who shall contact the utility company prior to bid for inclusion of these charges.

C. Arrangement with utility company for permanent electric service, including payment of utility company charges for service.

D. Assessments by the utility company for permanent electrical service shall be paid by the Owner.

E. Underground service entrance.

F. Metering equipment.

G. Temporary Service.

1.3 REFERENCE

A. ANSI/NFPA 70 National Electrical Code.

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

C. The rules and regulations of the local utility company shall govern all service and metering requirements.

1.5 COORDINATION

A. Fully coordinate with the local utility company to provide electrical service to the facility. Provide underground raceways, trenching, backfilling, etc. where required.

1.6 SUBMITTALS

A. Submit utility company prepared drawings.

B. Submit product data on:

1. Surge protective devices.
2. Lightning arresters.
3. Meter/C.T. cabinet if applicable.

1.7 QUALITY ASSURANCE

A. Perform work in accordance with utility company written requirements.

1.8 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated.

PART 2 - PRODUCTS

2.1 GENERAL

A. Refer to appropriate sections contained within these Specifications for standards concerning materials used.

2.2 UTILITY METERS

A. Meters will be furnished by utility company.

2.3 UTILITY METER BASE

A. Provide meter base that complies with utility company's requirements.

2.4 TRANSFORMER PAD

A. Description: Transformer pad sized as required by power company.

2.5 LIGHTNING ARRESTER

A. Unit shall be Tranquell type as manufactured by General Electric.

2.6 SURGE SUPPRESSION

A. Surge protective devices shall be in accordance with Section 26 43 00 Surge Protective Devices.

B. Surge protective devices shall meet the following criteria:

1. Lead Configuration: Lines 18” black, neutral 18” white, ground 18” green. Leads shall be #10 AWG copper and shall not be extended to more than 18" factory installed length.

2. Protective devices shall be connected to load side of circuit breaker in order to remove them from the circuit on failure; an indicator light should verify component failure. Provide circuit breaker sized as recommended by manufacturer in main panel and connect surge protective device.

3. Surge protective device shall be Atlantic Scientific Zonemaster 75 Series, unless otherwise specified in other sections of these Specifications, Section 26 43 00 Surge Protective Devices, etc. as applicable to project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that service equipment is ready to be connected and energized.

3.2 PREPARATION

A. Make arrangements with utility company to obtain permanent electric service to the project.

B. Coordinate location of utility company's facilities to ensure proper access is available.

C. This Contractor shall notify the utility company in writing, with two copies to the Engineer, no later than 10 days after signing contracts as to when this Contractor anticipates the building power service will be required.

D. Contact power company within 15 days of award of contract. Provide power company copies of contract documents needed and/or required by power company within 30 days of contract Notice to Proceed.

3.3 TEMPORARY SERVICES

A. Throughout the period of construction provide all temporary services and connections necessary to maintain, without interruption, all electrical services in support of construction and Owner activities. The only exception to this requirement shall be scheduled interruptions made with the prior acceptance of the Owner.

B. The facilities and equipment required to provide all electrical power for construction, lighting and balancing and testing consumed prior to final acceptance of the project shall be provided under this Section of the Specifications. All wiring, outlets and other work required to provide this power at the site and within the building for all trades shall be arranged for and furnished and installed under this Section of the Specifications including any fee, charge or cost due the utility company for temporary power installation or hook-ups.

C. Facilities shall be furnished in a neat and safe manner in compliance with governing codes, good working practices and OSHA regulations.

3.4 CONTRACTOR RESPONSIBILITIES

A. The Contractor shall furnish all labor, materials, etc. necessary for a complete accepted electrical service as required for this project, including inspection and acceptance by the utility and local inspection departments (if any) and inform the Engineer prior to energizing power lines within the structure.

3.5 UNDERGROUND ELECTRICAL SERVICE

A. Furnish and install underground service from power company’s pad mounted transformer to main service equipment. Seal conduit with duc-seal where entering building.

B. The underground service shall comply with all the requirements of the NEC, local utility company and state enforcing authority.

C. The concrete pad shall be furnished and installed by this Contractor and shall comply with the utility company's requirements.

D. Furnish and install buried primary conduits (minimum of 4” if not sized on the Drawings) from the pad to point of utility company service as shown on Drawings or as required by utility company.

E. Install service entrance conduits from utility company's pad mounted transformer to building service entrance equipment. Connect service lateral conductors to service entrance conductors.

3.6 METERING

A. Meters and metering equipment shall be furnished and installed under this Division of the Specifications.

3.7 LIGHTNING ARRESTERS AND SURGE PROTECTIVE DEVICES

A. Both lightning arresters and surge protective devices shall be provided on the line side of each main service from transformer. Units shall match service voltage.

B. Installation, including mounting connections, grounding and length of leads, shall conform to manufacturer’s recommendation.

C. Surge protective devices shall be installed in accordance with Section 26 43 00 Surge Protective Devices.

3.8 PAD

A. Install concrete pad as directed/required by utility company.

B. Cast-in place pads are to comply with all applicable divisions and sections of these Specifications.

END OF SECTION

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SECTION 26 27 16 - CABINETS AND ENCLOSURES

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. Provide and install cabinets and enclosures as specified herein for all systems specified in Divisions 26, 27, 28 when included with these Specifications.

B. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for the following:

1. Hinged cover enclosures.
2. Cabinets.

C. Cabinets and enclosures are to include:

1. Terminal blocks.
2. Mounting panel.
3. Ground bus/bar.
4. All accessories as required for a complete and operating system.

1.3 REFERENCES AND REGULATORY REQUIREMENTS

A. Conform to the requirements of the following:

1. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
2. NEMA ICS 4 Terminal Blocks
3. ANSI/NFPA 70 National Electrical Code

B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.4 SUBMITTALS

A. Submit Product Data: Provide manufacturer's standard data for enclosures and cabinets.

B. Submit Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under “References and Regulatory Requirements.” Include instructions for storage, handling, protection, examination, preparation, installation and starting of product.

C. Submit actual shop drawings on all cabinets and enclosures showing:

1. Covers.
2. Dimensions - inside and out.
3. Gauge of metal.
4. Manufacturer.
5. Terminal mounting plate, construction, etc.
6. Ground bus/bar.

1.5 EXTRA MATERIALS

A. Provide two of each cabinet key.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless specifically called for otherwise on Contract Drawings, provide cabinets as specified herein for terminal cabinets mounted indoors. Similarly, provide hinged cover enclosures as specified herein for terminal cabinets mounted outdoors or in locations other than NEMA 1 locations. Also provide hinged cover enclosures for locations where size required is not available in cabinet construction, or if specifically specified as enclosure in Contract Documents.

B. Size:

1. Dimensions of cabinets and enclosures shall meet the dimensions shown on Drawings, dimensions required by NEC, or dimensions sized as required to facilitate all equipment/connections involved installation, whichever is largest.

2. Coordinate with Division 27 Sections and Section 26 43 00 Surge Protective Devices of these Specifications to ensure size of equipment cabinet or enclosure will house and facilitate proper installation and access to equipment to be installed/mounted in cabinet or enclosure.

C. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power wiring.

D. Provide accessory feet and/or mounting brackets for free-standing equipment.

E. Cabinets and enclosures installed outdoors shall be fully weatherproof and watertight.

2.2 HINGED COVER ENCLOSURES

A. Construction:

1. Interior Locations: NEMA Type 1 steel (unless otherwise noted).

2. Exterior Locations: NEMA Type 4X.

a) Within 10 Miles of Ocean or Gulf: Stainless steel or fiberglass.

b) Other Exterior Locations: Primed and phosphatized steel.

B. Covers:

1. Continuous hinge.

C. Enclosure Finish:

1. NEMA 1:

a) Manufacturer's standard metallic gray enamel over phosphatized surfaces.

2. NEMA 4X:

a) Within 10 Miles of Ocean or Gulf: Stainless steel or gray gel coat on fiberglass.

b) Other Exterior Locations: Epoxy painted.

D. Lock/Handle:

1. Provide/install key lock handle on all enclosures mounted in rooms/areas/spaces that are not electrical rooms or mechanical rooms. Enclosures installed in electrical rooms need not be and are not required to be lockable.

E. Interior Mounting Plate:

1. Each enclosure is to have interior mounting plate/panel for mounting terminal blocks and

electrical components.

2. Plate/panel is to be metal.

F. Ground Bus/Bar:

1. Each enclosure housing surge protective devices or other equipment shall have local ground bar/bus installed. See “Local Ground Bus/Bar” below.

G. Manufacturers:

1. Hoffman
2. Electromate Corporation
3. Carlon for NEMA 4X
4. Square D

2.3 CABINETS

A. Construction: Code gauge steel with removable endwalls.

B. Finish:

1. Boxes: Galvanized steel.
2. Fronts: Gray baked enamel.

C. Fronts:

1. Electrical or Mechanical Room Locations: Screw cover with flush handle or as noted below.
2. Other Locations: Mono-flat with concealed trim clamps, concealed hinges, and flush lock lockable handle.
3. Flush or surface type as shown or called for in Contract Documents.

D. Interior Mounting Plate:

1. Each enclosure is to have interior mounting plate/panel for mounting terminal blocks and electrical components.
2. Panel/plate may be constructed of wood if painted with fire retardant paint of a flame spread rating of Class A, if it meets all applicable codes, and it is acceptable to the Authority Having Jurisdiction; otherwise plate to be metal.

E. Ground Bus/Bar:

1. Each cabinet housing surge protective devices or other equipment shall have local ground bar/bus installed. See “Local Ground Bus/Bar” below.

F. Manufacturer:

1. Sq. "D" Class 6650 Series.
2. Hubbell
3. Hoffman Electrical Products

2.4 TERMINAL BLOCKS

A. Terminal Blocks: ANSI/NEMA ICS 4.

B. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors rated 600 volts.

C. Signal and Control Terminals: Modular construction type suitable for channel mounting with

tubular pressure screw connectors rated 300 volts.

D. Provide ground bus terminal block with each connector bonded to enclosure.

2.5 LOCAL GROUND BUS/BAR

A. Size to handle #6 through #14 AWG copper ground wire.

B. Length as required for circuits.

C. Manufacturer:

1. Sq. "D" #PK***GTA Series.
2. Hubbell
3. Panduit

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install enclosures and cabinets plumb. Anchor securely to wall and structural supports at each corner.

C. Install cabinet fronts plumb.

D. Install per NEC and as required for proper clearance. Coordinate with panels.

E. Provide and install terminal cabinets as shown on Drawings or as required by the NEC.

F. Provide and install terminal cabinets wherever required for a complete and operating distribution system whether shown on Drawings or not.

G. Install local ground bus/bar in each terminal cabinet/enclosure that houses surge protective devices or other equipment and bond to cabinet enclosure via mounting screws or #6 AWG copper ground wire.

H. Ground local ground bus to systems ground bus/bar with minimum #6 AWG copper ground wire. Increase size if so required on Drawings.

I. Install enclosures.

END OF SECTION

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for the following:

1. Wall switches.
2. Wall dimmers.
3. Receptacles.
4. Device plates and decorative box covers.
5. External switches for VAV box equipment and duct heater equipment.

1.3 REFERENCES

A. NEMA WD 1 General Requirements for Wiring Devices

B. NEMA WD 5 – Wiring Devices, Special Purpose

C. NEMA WD 6 Wiring Devices Dimensional Specifications

D. NFPA 70E – Standard for Electrical Safety In The Workplace

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1. Submit product data on all types of wiring devices including plates and engraving.

B. Manufacturer's Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements.
2. Include instructions for storage, handling, protection, examination, preparation, operation and installation of product.

1.3 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years experience.

1.4 EXTRA MATERIALS

A. Provide a minimum of two screwdrivers of each type of tamper proof screw used on project.

B. Turn over to Owner and complete Spare Parts/Maintenance Stock Certification (Exhibit D) (see Section 01 77 00 Closeout Procedures).

PART 2 - PRODUCTS

2.1 GENERAL

A. All devices shall be Specification Grade as minimum.

B. General purpose wiring devices shall meet NEMA standard WD-1, Wiring Devices, General Purpose. Special purpose devices shall conform to the requirements of NEMA standard WD-5, Wiring Devices, Special Purpose.

C. All wiring devices shall bear UL labels.

D. All devices of one type (i.e. all snap switches, all duplex receptacles, etc.) shall be by the same manufacturer. Hazardous Location and Special Purpose devices may not be available from the same manufacturer; this shall constitute the only exception to this requirement of single source.

E. Corrosion resistant devices shall be as specified for normal usages and fabricated of yellow color melamine plastic. Where Weatherproof type is indicated for exterior or wet locations, provide matching self-closing cover, with gasketed seals at plate/wall junctions and for cover.

F. Provide factory packaged wiring devices having high impact strength molded plastic bodies.

G. Except where specifically required in these Specifications, use of interchangeable type or combination switch-receptacle-pilot devices is not acceptable and shall be removed.

H. All devices are to have terminals, terminations, lugs, etc., rated at 75 degree C as a minimum for use with 75 degree C and higher conductor ratings.

2.2 WALL SWITCHES

A. Manufacturers:

1. See Drawings.

B. General:

1. Snap switches for general use shall be maintained contact types, and shall be single-pole, double-pole, three-way, or four-way as required for the specific switching arrangements shown on the drawings. They shall be quiet tumbler operation types, having silver alloy contacts, and meeting all NEMA performance standards. Color to match plates unless specifically noted otherwise in specifications and/or on Drawings.

2. Switches shall be toggle or key-operated types, as indicated on the Drawings. All key-operated switches shall be keyed alike.

3. Where switches are denoted as having pilot lights, pilot lights shall glow when the switches are On. Provide pilot light switch with lamp and miniature step-down transformer. The pilot light shall have a red lens, and the lamp shall be long-life type.

4. Jewels for use with switches controlling motors shall be green, and jewels for other purposes shall be amber. All units shall be front relampable.

5. Snap switches installed in hazardous locations shall be UL listed for the type of location (class and division).

6. Voltage and ampere rating of switches shall be marked on switch, and shall conform to voltage of system to which applied.

C. Description: NEMA WD 1, heavy-duty, AC only general-use snap switch.

D. Voltage Rating: 120-277 volts, AC.

E. Current Rating: 20 amperes minimum.

F. Ratings: Match branch circuit and load characteristics.

2.3 EXTERNAL SWITCHES FOR VAV EQUIPMENT AND DUCT HEATER EQUIPMENT

A. Provide external disconnect switches adjacent to VAV boxes and duct heaters, sized per electrical load of the VAV and duct heater equipment. Provide “lock-out” or “switch guard” mounted over toggle switch bolted to cover plate.

1. Legrand #PS20AD1 w/7801P (for single-phase, 277V up to 20 amp circuits).

2. Legrand #7803 w/7801P (for three-phase, 480V up to 30 amp circuits).

3. For circuits larger than above, provide suitable motor-rated switch with lockout provision or heavy duty enclosed disconnect switch.

2.4 WALL DIMMERS

A. Manufacturers:

1. See Drawings.

B. Description: NEMA WD 1, semiconductor dimmer for incandescent lamps, type as indicated on Drawings.

C. Device Body: Plastic with rotary knob or linear slide as called for on Drawings.

D. Voltage: 120 volts or as required to match application.

E. Power Rating: Match load shown on Drawings; 600 Watts minimum.

F. Accessory Wall Switch: Match dimmer appearance.

1. Same manufacturer and style as dimmer switch.

2.5 RECEPTACLES

A. General:

1. All receptacles shall be of standard NEMA configuration, as indicated on the drawings, and shall comply with the respective ANSI C 73 series standard for the NEMA configuration. Color to match plates unless specifically noted otherwise in specifications and/or on drawings.

2. Duplex receptacles shall have integral UL listed self-grounding clips. Similar, single receptacles shall be provided for plug-in connections of industrial fluorescent light fixtures on the same switching circuit. Receptacle face to be impact resistant nylon.

3. Weatherproof duplex receptacles shall be provided in all exterior locations, and shall be ground fault circuit interrupting (GFCI) types, with weatherproof cover plates allowing use of receptacle with cover in closed position.

4. Special purpose receptacles for specific equipment shall be grounding types, having the number of poles, voltage and ampere ratings, and NEMA configurations required by the equipment. For each special purpose receptacle, provide an identical mating plug equipped with cord grip, secured to cord.

5. Duplex receptacles shall have back and side wired screw pressure terminals.

B. Description: NEMA WD 1; heavy-duty general use receptacle.

C. Configuration: NEMA WD 6; heavy-duty, general use type as specified and indicated.

D. Convenience Receptacle: Type 5-20.

E. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

F. Manufacturers:

1. See Drawings.

2.6 COVER PLATES

A. All wiring devices shall be provided with standard size one-piece cover plates of suitable configuration for the number and type of devices to be covered.

B. Metallic cover plates shall be used in interior spaces, except as noted below, and shall be fabricated of corrosion-resistant #302 stainless steel, having a nominal thickness of .04", and a brushed finish. Screws securing the plates shall have flush (when installed) heads with finish to match plates. Metallic cover plates shall meet all requirements of the National Electrical Code and Federal Specifications.

C. Cover plates for switches located in corrosive atmosphere (where vapor proof is not indicated) shall be equal to Hubbell #17CM81/#17CM82/#17CM83/#17CM84 one-piece neoprene with matching presswitch.

D. Cover plates for exterior receptacles shall be gasketed covers with hinge allowing plug and cord to be plugged in and activated with cover closed.

E. Cover plate engraving, where required, shall be accomplished by cover plate manufacturer in accordance with instructions given on the drawings. Metallic plates in ivory, beige, gray, and white shall be engraved with black fill. Red, brown, and black plates shall be engraved with white fill.

F. Cover plates for computer power receptacles shall have “COMPUTER” engraved in them.

2.7 COLOR

A. Wiring devices connected to normal power and located in unfinished spaces shall be grey color. Devices connected to normal power and located in finished interior spaces shall be ivory color, unless otherwise required by Owner.

B. Receptacle devices for computer power shall be black.

C. Cover plates for devices connected to normal power and located in finished interior spaces shall be color selected by Architect from the above list of standard colors or #302 stainless steel.

D. All devices and coverplates in paneled walls shall have finish to match paneling.

E. Devices where established building standards and/or isolated ground devices require otherwise. Coordinate before purchase.

F. Contractor shall modify any given catalog number as required to procure devices and plates of the proper color.

2.8 FLUORESCENT DIMMERS

A. Dimmers shall be electronic type equal to type specified on drawings. Dimmers shall be complete including remote control where required. Special dimming ballasts shall be included on fixtures to be dimmed. Ballasts shall be approved by the dimmer manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify conditions under provisions of Division 01 General Requirements, and any other applicable supplemental requirements/conditions.

B. Verify outlet boxes are installed at proper height.

C. Verify wall openings are neatly cut and will be completely covered by wall plates.

D. Verify floor boxes are adjusted properly.

E. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

E. Do not share neutral conductor on load side of dimmers.

F. Install receptacles with grounding pole on bottom.

G. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

H. Electrical boxes shall be cleaned and completely free of any debris, dust, etc. prior to the installation of wiring devices.

I. Where two or more switches or receptacles are to be installed adjacent to one another, provide a multi-gang box and combination multi-gang coverplate. Provide proper NEC barriers in boxes which serve devices for both the Normal and Emergency Systems.

J. Provide device coverplates for every device installed. Cover plates shall be installed so that they appear straight with no gaps between plate edges and the wall. Maintain vertical and horizontal to within 1/16 of an inch.

K. In finished areas provide same type of plate for all surface mounted devices as for recessed mounted devices.

L. In any room where new and existing construction is present, all receptacles, switches, and coverplates which are existing to remain shall be changed as required to match new work.

M. Wiring devices shall not be installed in exposed masonry until cleaning of masonry with acids has been completed.

N. All receptacles and switches shall be grounded by means of a ground wire from device ground screw to outlet box screw and branch circuit ground conductor. Strap alone will not constitute an acceptable ground.

O. All wiring devices, relays, contactors, pushbuttons, selector switches, pilot lights, etc. shall be installed in approved enclosures rated for the appropriate NEMA classified environment.

P. All devices shall be installed so that only one wire is connected to each terminal.

Q. Once construction is substantially completed, replace all damaged, burned, or scorched wiring devices.

R. Receptacles shown to be floor mounted shall be installed in floor boxes (with coverplates) which are approved for this use.

S. Connect wiring devices by wrapping conductor around screw terminal.

T. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

U. Install protective rings and split nozzle on active flush cover service fittings.

V. Install local room area wall switches at door locations on the lock side of the door approximately 4” from the jamb. Where locations shown on the Drawings are in question, provide written request for information to A/E prior to rough-in.

W. External disconnect switches for VAV and duct heater equipment shall be mounted within 5’-0” of the unit.

3.4 NEUTRAL CONDUCTOR CONNECTIONS

A. Each receptacle’s "in" and "out" phase and neutral conductors shall have an additional conductor for connection to device. The practice of "looping" conductors through receptacle boxes shall not be acceptable.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes provided under other Sections of these Specifications to obtain mounting heights specified and indicated on Drawings.

3.6 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

3.7 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

END OF SECTION

SECTION 26 28 19 - ENCLOSED DISCONNECT SWITCHES

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. Provide all labor, materials, and equipment necessary to properly install switches as shown on the Drawings and as required by codes.

B. Coordinate with Division 23 Contractor and Specifications as to who is to provide disconnect switches for mechanical equipment. Provide all disconnect switches not being provided by Division 23 Contractor.

1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver switches in factory wrapped packaging to the site. Handle switches carefully to prevent damage. Store in a clean, dry space protected from dirt, water, and physical damage. Do not install damaged switches.

1.4 QUALITY ASSURANCE

A. The manufacturer of switches shall be the same as that of the panelboards.

1.5 SUBMITTALS

A. Submit catalog cut sheet on each type of disconnect switch to be used on this project.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

A. Switches shall be heavy duty types with visible, quick-make, quick-break blades.

B. Units for 2-speed motors shall be 6-pole in a single enclosure. Use of two 3-pole units will not be acceptable.

C. Provide ground bus, and where required a solid neutral bus.

D. Switches shall be fusible or nonfusible as denoted on the Drawings or as required by the equipment served from the switch. Fusible switches shall have rejection type fuse holders.

E. Terminal lugs shall be rated for 75 degrees Centigrade.

F. Enclosures, unless otherwise noted, shall be NEMA 1 for indoor locations and NEMA 3R for outdoor locations as a minimum, except where indicated as NEMA 4X.

G. The enclosure shall be interlocked with the switch handle such that the enclosure door or cover cannot be opened with the switch in the "ON" position. The switch handle shall be capable of being padlocked in the "OFF" position but not in the "ON" position.

H. Finish for NEMA I units shall be standard baked gray enamel finish over a rust inhibiting phosphate primer.

2.2 Disconnect switches installed between any variable speed drive type of unit (VFD, AFD, USD, etc.) and its respective motor(s), shall have auxiliary break before break (open) interlock control contact.

A. Disconnect switches installed to disconnect HVAC equipment are to be fusible type with fuses as recommended by HVAC manufacturer.

2.3 RATING

A. The size, number of poles, and fusing for each switch shall be as denoted on the Drawings. As a minimum, no less than one pole for each ungrounded conductor shall be provided. Switches shall be rated 250 VAC or 600 VAC as required by the circuit to which it is connected.

B. Switches serving motors with more than one set of windings shall have the number of poles necessary to disconnect all conductors to all windings in a single switch. Switches serving motor loads shall be horsepower rated of sufficient size to handle the load.

2.4 SERVICE ENTRANCE EQUIPMENT

A. Switches used as service entrance equipment shall be listed and labeled by UL for use as service equipment.

2.5 ENCLOSED CIRCUIT BREAKERS

A. Molded Case Circuit Breakers: NEMA AB1, plug-on type for 250V or less, bolt-on type for over 250V, thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Breakers shall be HID rated. Provide UL Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers.

B. Thermal-magnetic, molded case, with inverse time-current overload and instantaneous magnetic tripping, unless otherwise shown. Breakers shall be calibrated for 40 degrees C or shall be ambient compensating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. install all switches in accordance with the manufacturer's written instructions, NECA National Electrical Installation Standards, the applicable requirements of the NEC, and recognized industry practice.

B. All switches shall be firmly anchored to walls and supporting structures (where used) using appropriate installation. Switches shall be installed with the turning axis of their handles approximately 5'-0" above finished floor unless otherwise indicated. Provide rigid steel (galvanized for exterior use) mounting stands, brackets, plates, hardware, and accessories for a complete installation.

C. Switches shall be mounted in accessible locations chosen where the passageway to the switch is not likely to become obstructed. Where a switch serves as the disconnecting means for a load, the switch shall be located as close as practical to the load with the switch handle within sight of the load.

D. Provide and install lugs on disconnect switch as required to accept conductors called for on Drawings.

E. Disconnect switches shall not be mounted on equipment unless specifically noted or required and meet all applicable codes, etc. If switches are noted or required to be mounted on equipment they shall have vibrator clips on fuses and be connected to conduit system with liquid tight flexible conduit.

F. Coordinate all requirements for controls between variable speed drive unit and its respective motor with drive specification, manufacturer, provider and installer. Provide auxiliary contacts, relays, etc. as required.

END OF SECTION

SECTION 26 29 13 - MOTOR 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. This Section of the Specification covers factory-assembled, metal-enclosed motor control units for distribution and control of power from incoming line terminals to outgoing feeder terminals, installed and tested in place.

B. Motor control units shall include all protective devices and equipment as listed on Drawings or as included in these Specifications, with necessary interconnections, instrumentation, and control wiring.

1.3 FURNISHING OF EQUIPMENT

A. Unless specifically noted otherwise, automatic motor starters for all equipment requiring them shall be furnished under the section or division where equipment is specified, and installed under this Section of the Specifications.

B. Provide all labor, materials, and equipment necessary to properly install all motor starters. Provide motor starters for all new motors to be wired, where starters are not specified elsewhere, under work of the division which provides the motored equipment.

C. Unless specifically noted otherwise, manual motor starters shall be furnished and installed under this Section of the Specifications.

D. Disconnect switches for 120V fractional hp exhaust fans to be provided by Division 23 Contractor at exhaust fan. Any other required disconnect switch to be provided and installed by Division 26 Contractor.

E. Provide and install 75 degree rated lugs on all non-unitary mechanical equipment such as pumps, air handling units and individual motor units/equipment. Coordinate with Division 23 Contractor prior to bid.

1.4 CONTROL ITEMS

A. Unless specifically noted otherwise, all control, alarm and interlock wiring required for proper operation of equipment furnished by any other contractor and the required raceways shall be furnished and installed under the Division where the equipment is specified.

B. Where required by Electrical Drawings, Division 23 Specifications., and/or Mechanical Drawings, this Contractor shall connect power feeder to mechanical equipment via control devices furnished by Division 23 Contractor (i.e., starters, line voltage, t'stats, line voltage switch, control relays, etc.).

C. Provide and install power circuits to all control devices requiring them (i.e., 120V dampers, control panels, control devices, etc.) whether shown on Drawings or not. Coordinate requirements of all Divisions and/or Sections of these Specifications prior to bid.

1.5 SUBMITTALS

A. Shop Drawings and Product Data:

1. Shop Drawings, Individually Mounted AC Manual Starter:

a) Shop drawings shall clearly indicate:

1. Frame sizes and interrupting capacity of manual starter and/or disconnect unit.

2. Horsepower rating at rated voltage of manual starter and/or disconnect unit.
3. Electrical ratings.
4. Single line diagram for power and control connections with numbered terminals and all required accessories.
5. All required accessories.

2. Shop Drawings, Individually Mounted AC Magnetic Starter:

a) Shop drawings shall clearly indicate:

1. Frame sizes and interrupting capacity of starter and/or disconnect unit.
2. Horsepower rating at rated voltage of starter and/or disconnect unit.
3. Electrical ratings.
4. Single line diagram for power and control connections with numbered terminals and all required accessories.
5. All required accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design:

1. Square D

B. Accepted Substitutions:

1. General Electric
2. Siemens/ITE

2.2 GENERAL

A. Motor starters shall be manual, magnetic, or combination type as denoted on the Drawings.

B. Pilot lights shall have long-life lamps rated 7500 hours minimum.

C. Enclosures shall be NEMA 1 for indoor locations and NEMA 3R for outdoor or wet locations except where indicated as NEMA 4X.

D. Multi-speed or stop type controllers shall have thermal overload relays in each ungrounded conductor for each speed or step.

E. Where multi-speed motors are scheduled on the Drawings, the motor controls shall be compatible with the type motor and have adjustable time deceleration for transition from high to low speeds.

2.3 INDIVIDUALLY MOUNTED AC MANUAL STARTERS

A. Where manual motor starter switch is called for on Drawings, it shall be a combination across-the-line manual type starter with overloads and disconnect rated in accordance with NEMA standards, sizes and horsepower rating. Final rating of overloads shall be field set and recorded. Unit shall be mounted on NEMA 1 enclosures, unless otherwise noted.

B. Manual motor starter switch shall include green "run" pilot light, and shall be surface or flush mounted as noted on Drawings.

2.4 INDIVIDUALLY MOUNTED AC MAGNETIC STARTERS

A. Combination Starter and Disconnect:

1. Where combination starter and disconnect switch is called for on Drawings, it shall be a combination across-the-line magnetic type starter with motor circuit protection (magnetic only breaker) disconnect, rated in accordance with NEMA standards, sizes and horsepower rating. Final magnetic setting of MCP shall be field set and recorded with Unit shall be mounted on NEMA 1 enclosures, unless otherwise noted.

B. Individual Starter Without Disconnect:

1. Where individually mounted starter is called for on drawings, it shall be across-the-line magnetic type rated in accordance with NEMA standards, sizes, and horsepower ratings. Unit shall be mounted on NEMA 1 enclosure, unless otherwise noted.

C. Starters:

1. Motor starter, unless otherwise noted, shall be across-the-line magnetic type rated in accordance with NEMA standards, sizes, and horsepower ratings. Starters shall be equipped with double break silver alloy contacts. All contacts shall be replaceable from front without removing starter from enclosure. Overload relays shall be provided in each phase, and shall be melted alloy or bimetallic type. Thermal units shall be of the one-piece construction and interchangeable.

2. Starters shall be equipped with minimum of two (normally open) auxiliary contacts in addition to the normally open auxiliary seal-in interlock and shall be suitable for the addition of at least two additional external electrical interlocks, one normally open and one normally closed. All starters shall have red "run" pilot light, "Hand-Off-Auto" selector switch, and nameplate. Control voltage shall be as required. Starters shall contain fused control transformers to provide correct control voltage.

3. Starter for all motors sized 1 hp or larger shall include 3-phase power monitor as manufactured by Time Mark Corporation (Model #A258B for 480V, 3-phase system) (Model #258B for 208V/240V, 3-phase system) (Model #B258B for 120V system) providing solid state protection by opening starter for loss of any phase, low voltage of any or all phases, and phase reversal. Monitor shall be field adjustable for drop-out voltage of (340-480VAC) (160-240VAC) (85-125VAC).

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine area to receive motor-control units to assure adequate clearance for motor control unit installation.

3.2 INSTALLATION

A. Install motor control units in accordance with manufacturer's written instructions and NEC.

B. All starters and their respective enclosures shall be firmly anchored to walls and supporting structures (where used) using appropriate hardware. Provide supporting (unistrut type) channels on walls constructed of gypsum board or where otherwise necessary to provide a mechanically secure and permanent installation. Starters shall be installed with their turning axis of their handles approximately 5'-0" above finished floor. Provide rigid steel (galvanized for exterior use) mounting stands, brackets, plates, hardware, and accessories for a complete installation.

C. Starters shall be mounted where shown on the Drawings. Where the starter also provides the code-required disconnecting means for a load, the starter shall be located within sight of the load and as close as feasible.

D. Provide fusing for all fusible switches.

E. Provide properly sized heater elements for every starter overload relay. The element shall be sized using the nameplate full load running current of the actual equipment supplied to the job.

F. Provide a heater element selection chart on the inside of each starter door.

G. Provide spare pilot light lamps to the Owner. Provide two of each type and size load.

H. Provide nameplate for each control unit.

I. Coordinate conductor terminations on all equipment connections. Replace all 60 degree lugs/connections with 75 degree lugs/connections.

3.3 ADJUSTMENT AND CLEANING

A. Adjust operating mechanisms for free mechanical movement.

END OF SECTION

SECTION 26 41 13 - LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Air terminals and interconnecting conductors.
2. Grounding and bonding for lightning protection.

B. A Lightning Protection System shall be provided and installed on the structure(s) (even though not shown on Drawings), by experienced installers in compliance with provisions of the code for Lightning Protection Systems as adopted by the National Fire Protection Association and Underwriters Laboratories. All equipment to that result shall be included whether or not specifically called for herein, with the additional requirement that the system shall meet all the requirements of LPI.

C. Bond/ground all building mounted and/or grade mounted antennae and satellite systems/dishes.

D. Provide complete lightning protection system for all pavilions and/or structures, including but not limited to all shelters and playground pavilions and canopies.

E. Materials shall comply in weight, size and composition with the requirements of Underwriters Laboratories and the National Fire Protection Code relating to this type of installation, and shall be UL labeled.

F. All materials, where available by any one manufacturer, shall be cast.

1.3 REFERENCES

A. ANSI/NFPA 780 Standard for the Installation of Lightning Protection Systems

B. ANSI/UL 96 Lightning Protection Components

C. UL 96A Installation Requirements for Lightning Protection Systems

D. LPI Lightning Protection Institute

E. OSHA Standard 29 CFR

F. Section 26 05 26 Grounding and Bonding

G. Section 26 08 13 Tests and Performance Verification of Electrical Systems

1.4 REGULATORY REQUIREMENTS

A. System shall comply with the following:

1. ANSI/NFPA 780 Class I
2. UL 96A Master Label

1.5 SUBMITTALS

A. Submit shop drawings showing layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details. Drawings shall include full layout of cabling and points, and connections.

B. Submit product data showing dimensions and materials of each component, and include

indication of listing in accordance with ANSI/UL 96.

C. Submit manufacturer's installation instructions.

D. Submittal shall include ground wells as called for in Section 26 05 26 Grounding and Bonding.

1.6 PROJECT RECORD DOCUMENTS

A. Submit project record documents.

B. Accurately record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in lightning protection equipment with minimum five years documented experience and member of the Lightning Protection Institute.

B. Installer: Authorized installer of manufacturer with minimum five years documented experience and member of the Lightning Protection Institute.

1.8 PRE-INSTALLATION CONFERENCE

A. Convene a pre-installation conference one week prior to commencing work of this Section.

1.9 SEQUENCING AND SCHEDULING

A. Coordinate the work of this Section with roofing and exterior and interior finish installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Thompson Lightning Protection, Inc. - Premium Line

B. Independent Protection Company, Inc. - Premium Line

C. Heary Bros. Lightning Protection - Premium Line

D. Harger Lightning Protection, Inc. - Premium Line

2.2 MATERIALS

A. Components: In accordance with ANSI/UL 96 and LPI.

B. Air Terminals:

1. Air Terminals shall be solid (aluminum or copper) as required to match roof conductors, shall have proper base support for surface on which they are attached, and shall be securely anchored to this surface.

2. Terminals shall be of such length as to comply with NFPA 780.

3. Air Terminal for Chimney: Lead-coated copper.

4. Air terminals shall be powder-coated safety yellow or orange to identify potential impalement hazard.

C. Conductors:

1. Roof conductors shall consist of (aluminum or copper) complying with the weight and construction requirements of the code. Roof conductor material shall match and/or be compatible with roof flashing material.

2. Down conductors shall be copper and shall be provided where shown installed in PVC conduit and hidden within the structure.

3. If routing of down conductor raceway is in location where PVC is not allowed per code,

install in metal conduit to meet code and bond both ends.

D. Fastener:

1. Conductor fasteners shall be of the same material as the conductor, having ample strength to support conductor.

2. Cable and aerial’s shall have sacrificial pads installed at all locations required.

E. Connectors and Splicers:

1. Above Grade and Accessible: They shall be bronze or aluminum as required to be compatible with conductor being connected.

2. Below Grade or Concealed: Exothermic connections.

F. Ground Rods:

1. Ground rods shall comply with all requirements of Section 26 05 26 Grounding and Bonding, and Section 26 08 13 Tests and Performance Verification of Electrical Systems.

2. Install in ground wells in accessible area (not in sidewalks unless specifically accepted by Engineer).

G. Ground Plate: Copper.

H. Thru-Roof Assembly:

1. Pre-manufactured assemblies consisting of a base plate/cable connector, threaded riser bar, 2-3/8” OD PVC support tube, and cap/cable connector.

2. Basis of Design: Harger 230 Series Thru-Roof Assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify that field measurements are as shown on shop drawings.

C. Beginning of installation means installer accepts existing conditions.

3.2 PROTECTION OF SURROUNDING ELEMENTS

A. Protect elements surrounding work of this Section from damage or disfiguration.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with UL 96A, ANSI/NFPA 780, and LPI.

C. Install ground rods in accordance with Section 26 05 26 Grounding and Bonding. Where conflict exists between the requirements of Section 26 05 26 Grounding and Bonding and this Section, the most stringent shall govern.

D. Installation shall be made in an inconspicuous manner with conductors coursed to conceal equipment as much as possible. Down conductors shall be concealed within structure, and shall be run in 1" conduit complying with NEC. See Paragraph 'F' below and NFPA 780 4.15.1.

E. Where fasteners are to be mounted in masonry or structural work, they shall be furnished to the Masonry or Structural Contractor so they may be installed during construction of the project.

F. Conductors concealed in steel reinforced concrete shall be installed, bonded, etc. per NFPA 780 4.15.3. Specific attention is brought to the requirements of NFPA 780 4.9.13 requiring down conductors to be connected to reinforced steel at its upper and lower extremities.

G. Lightning protection system shall be bonded to metal bodies as required by NFPA 780 4.21.

1. The Contractor shall provide proper connection of the lightning protection system to all grounded media in and around the protected structure (see NFPA 780 4.20 Potential Equalization).

2. The Contractor shall provide proper grounding of all grounding media in, on, and around structure to provide common ground potential per NFPA 780 4.14 including electric service, telephone and antenna system grounds, underground metallic piping systems, and underground metal conduits.

3. All fences, gates, handrails, metal flagpoles, metal bleacher seats, metal playground equipment shall be grounded and bonded to the grid.

4. Bond/ground all building mounted and/or grade mounted antennae and satellite systems/dishes.

H. Provide proper connections of lightning protection system to all grounded media in and around the protected structure per NFPA 780 4.20 Potential Equalization.

I. Provide proper grounding of all grounding media in, on and around structure to provide common ground potential per NFPA 780 4.14, including electric service, telephone and antenna system grounds as well as underground metallic piping systems, underground metal conduits, etc.

J. Ground Ring: Bond to ground ring system. See Section 26 05 26 Grounding and Bonding. Items required to be bonded/connected in 'H' and 'I' above shall be bonded/connected via ground ring system where available and applicable.

K. All exposed conductors located 6’ or less above finished floor or finished grade is to be suitably protected/shielded as well as other exposed locations where conductor is subject to mechanical damage.

L. Coordinate and receive acceptance of all penetrations of roofing system and mounting to roofing system with Architect and Roofing Contractor prior to submittal of shop drawings. The use of pitch pockets is not acceptable.

M. Coordinate and receive acceptance of all connections to structural steel, rebar, etc. with Structural Engineer prior to submittal of shop drawings.

N. Submittal of shop drawing by Contractor is evidence that the Contractor has received acceptance of penetrations, connections, etc. by all parties and that Contractor assumes responsibility for such penetrations, connections, etc.

O. Ground Terminals:

1. Ground connections shall be made in accordance with requirements of all applicable codes and Section 26 05 26 Grounding and Bonding (including but not limited to requirements for testing, ground rods, materials, wells, etc.).

2. Ground rods shall be placed outside, a minimum of 2’ from building foundations. Top of rod shall be at least 1’ deep into earth (i.e. with minimum earth cover of 1’). Install in ground well. Install gravel/rock in base of all ground well, from well bottom to minimum of 6” below well bottom.

3. Each and every ground rod location shall consist of:

a) Two or more 30’ ground rods (5/8" copper) at no less than 30’ spacing shall be driven vertically to a depth resulting in 1’ earth cover.

b) Bond the two or more ground rods together with a cable size that meets the applicable requirements of NFPA 780 for Class I or II locations as applicable.

c) Provide additional rod electrodes as required to achieve specified ground resistance.

d) Complete installation shall exceed the minimum requirements of NFPA 780.

e) Provide grounding well enclosure at each ground rod location in accordance with Section 26 05 26 Grounding and Bonding.

P. Install in accordance with OSHA Standard 29 CFR Regulations 1910.23(c)(3), 1910.212, 1926.501(b), and the intent of 1926.701(b) Guarded Requirements.

3.4 FIELD QUALITY CONTROL

A. Test grounds per Section 26 05 26 Grounding and Bonding and Section 26 08 13 Tests and Performance Verification of Electrical Systems.

B. Obtain the service of Underwriters Laboratories to provide inspection and certification of the lightning protection system under provisions of UL 96A.

C. Obtain UL Master Label and attached to building at location directed by Owner.

D. Submit test results on each ground location including final length of each ground rod and final distance between each installed ground rod at each ground rod location.

END OF SECTION

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SECTION 26 43 00 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Transient Voltage Surge Suppression (TVSS) or Surge Protective Devices (SPD) includes all electrical systems and devices specifically installed in facility electrical systems to protect all electrical circuits, electronic equipment and building mechanical systems from the effects of lightning induced voltages, external switching transients and internally generated switching transients.

1.3 APPLICATION

A. Surge suppression, grounding and bonding shall effectively protect the systems to which they are applied against lightning, transients, internal spikes, and other surge transients throughout the useful life of the systems, and shall be designed and installed in such a manner that normal operation, performance ratings and listing of the system is not impaired by the installation of such devices, wiring or connections.

B. Surge protective devices shall be installed on all service entrance equipment (to include distribution panels and panelboards in separate buildings that perform the function of service entrance equipment for that particular building), distribution panels, lighting and appliance panelboards that may feed any electronic equipment (to include personal computers, copiers, printers, fire alarm panels, building management systems, intercom systems, etc.), any circuits leaving the building e.g. outdoor lighting, and all signal circuits (data, telephone, fire alarm, intercom, etc.) leaving or entering a building.

C. Transient Voltage Surge Suppression shall be included in the electrical design of all facilities and shall not be omitted for any reason.

1.4 REFERENCES

A. ANSI/IEEE C62.33 Standard Test Specifications for Varistor Surge Protective Devices

B. ANSI/IEEE C62.35 Standard Test Specifications for Avalanche Junction Semiconductor Surge Protective Devices

C. ANSI/IEEE C62.36 IEEE Standard Test Methods for Surge Protectors Used in Low-Voltage Data, Communications and Signaling Circuits

D. ANSI/IEEE C62.41 IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits (Categories A, B, C and Table 8, High Exposure 10 x 1000 µs Waveform Testing

E. ANSI/IEEE C62.45 IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits

F. IEEE Standard 142 IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems

G. IEEE Standard 1100 Recommended Practice for Powering and Grounding Electronic Equipment

H. NFPA 70 National Electrical Code

I. NFPA 75 Standard for the Protection of Information Technology Equipment

J. NFPA 780 Standard for the Installation of Lightning Protection Systems

K. UL 497A Standard for Secondary Protectors for Communications Circuits

L. UL 497B Communications and Fire-Alarm Circuits

M. UL 1283 Standard for Safety for Electromagnetic Interference Filters

N. UL 1449, 3rd Edition Standard for Safety for Surge Protective Devices

1.5 MANUFACTURER QUALIFICATIONS

A. Manufacturer: Company specializing in surge suppression equipment of the type herein specified with a minimum ten years documented experience.

B. Repair: The surge protective device manufacturer shall offer factory repair service and/or replacement for all units. The manufacturer shall provide this service within four working days and provide replacement components shipped to the Owner for installation within the allocated response time.

C. Installation Certification: As a part of the close-out documentation, the Contractor shall submit a letter from the surge protection manufacturer stating that the installation has been inspected by the manufacturer or the manufacturer’s representative. The certification letter must state that the installation has been done in accordance with the manufacturer’s requirements and the warranty is in effect. Submit five copies to the Engineer for review.

1.6 WARRANTY

A. Period: All surge protective devices and supporting components shall be guaranteed by the installing contractor to be free of defects in materials and workmanship for a period of ten years from the date of substantial completion of service activation for the system to which the suppressor is attached.

B. Replacement: Any suppressor which shows evidence of failure or incorrect operation during the warranty period shall be repaired or replaced at no expense to the Owner including labor and materials. Since “Acts of Nature” or similar statements include the lightning threat to which these suppression devices shall be exposed, any such clause limiting warranty responsibility in the General Conditions of this Specification shall not apply to this Section. The warranty shall cover the entire device.

C. Installation: Installation of SPDs in or on electrical distribution equipment shall in no way compromise or violate equipment listing, labeling, or warranty of the distribution equipment.

1.7 SUBMITTALS

A. General: SPD wiring, bonding and grounding connections shall be indicated on the wiring diagrams for each system. Include installation details demonstrating mechanical and electrical connections to equipment to be protected.

B. Testing: The test data submitted shall be specific for the actual method on installation proposed. Submittals will not be reviewed unless they include proper project related data. Interpretation of standard manufacturer’s published data will not be acceptable unless the data coincides with the actual installation procedure.

C. Submittals: The surge protection submittal shall include, but shall not be limited to the following additional data:

1. Complete data for each suppressor type indicating conductor sizes, conductor types, connection configuration, lead lengths and all appropriate dimensions.

2. Dimensions for each suppressor type indicating mounting dimensions and required accessory hardware.

3. Manufacturer’s certified test data indicating the ability of the product to meet or exceed requirements of this specification, including 10 x 1000 μs recognized independent lab testing.

4. If requested, a sample of each suppressor type to be used for testing and evaluation shall be submitted.

5. Drawings shall be provided indicating surge protective device mounting arrangement and lead length configuration.
6. List and detail all protective systems such as fuses, disconnecting means and protective materials.
7. Documentation of type of suppression components utilized within the SPD to perform the rated and tested purpose. Documentation provided to UL for listing purposes is acceptable. Confidentiality agreements will be signed as required for access to this documentation.
8. Documentation shall be provided that the SPDs being supplied have passed UL 1449 3rd Edition.

PART 2 - PRODUCTS

2.1 POWER

A. General:

1. The ac voltage surge protective device shall be a high speed, high current solid-state device designed to protect electronic equipment and electrical systems from transient over voltages. It shall limit the magnitude of a transient overvoltage present on the ac service or distribution power lines. The suppressor shall provide continuous bi-polar, bi-directional, non-interrupting protection and be capable of instant automatic reset with no degradation in protection capabilities. Gas tubes are not acceptable. The suppressor shall be solid state, utilizing silicon junction avalanche diodes or MOVs. It shall start to suppress the transient at a minimum of 115 percent of the peak voltage of the sine wave. The suppressor assembly shall be installed in parallel with the service main disconnect, distribution or branch panel main lugs as shown. Connect suppressor to overcurrent protection sized as shown with an AIC rating equal to panel rating. The suppressor shall be contained in an enclosure appropriate for the environmental application. Provide one complete spare surge protective device for each type of suppressor specified herein or called for on the Drawings for the Owner’s use.

2. Electrical Service

a)	Voltage	480/277 VAC	120/208 VAC
b)	Frequency	50/60 Hz	50/60 Hz
c)	Phases	3 phase	3 phase
d)	Wiring configuration	4 wire, Wye	4 wire, Wye
e)	IEEE C62.41 (1991) (Table 4) categories unless otherwise indicated on the Drawings:		
	Service Entrance*	C3	C3
	Distribution Panels	C3	C3
	Panelboards	C3	C3

*INCLUDES DISTRIBUTION PANELS AND LIGHTING AND APPLIANCE PANELBOARDS THAT PERFORM THE FUNCTION OF SERVICE ENTRANCE EQUIPMENT.

f) IEEE C62.41 (Table 8) 10/1000 waveform requirements. Use “High Exposure” level for all suppressor locations.
.9 kV & 3.6 kA 0.39 kV & 1.56 kA

3. Electrical Performance

a) Min. Voltage Protection Level (MVPL) (10 x1000 μsec waveform)
470V peak 200V peak

b) Max. Voltage Protection Level (10 x1000 μsec waveform)
800V 350V

peak peak

c) Max. Voltage Protection Level per IEEE C62.41.2 (20 kV 1.2/50 μs; 10 kA 8/20 μs)
1000V 600V
peak peak

d) Max. Continuous Operating Voltage (MCOV) of nominal line
115% 115%
(min.) (min.)

e) Response Time ≤5 ns ≤5 ns

f) Minimum Service Life: The suppressor shall be provided with a ten year unconditional warranty or shall meet the following surge tests without being damaged or changing the voltage protection level (clamping voltage) by ±10% of initial value provided. Maximum 50-60 seconds between pulses.

1. Shortwave Test – surge current (20 kV, .2/50 μs; 10 kA, 8/20 μs)

   1000 surges 1000 surges

2. Longwave Test – surge current (10 x 1000 μs) (.9 kV & 3.6 kA @ 277V and 0.39 kV & 1.56 kA @ 120V)

   1000 surges 1000 surges

g) Temperatures:

1. Operating 0°C to +50°C. 0°C to +50°C.
2. Storage -20°C to +65°C. -20°C to +65°C.

B. Service Entrance Suppressors:

1. Surge Protective Device Description: Modular design with field replaceable modules and the following features and accessories:
   a) Fabrication using bolted compression lugs for internal wiring.
   b) Replaceable modules.
   c) Arrangement with wire connections to phase buses, neutral bus, and ground bus.
   d) LED indicator lights for power and protection status.
   e) Audible alarm, with silencing switch, to indicate when protection has failed.
   f) One set of dry contacts rated at 5A and 250V ac for remote monitoring of protection status. Coordinate with building power monitoring and control system.
2. Peak Single-Impulse Surge Current Rating: 240 kA per phase.
3. Connection Means: Permanently wired through 3 phase breaker (the size of the breaker as recommended by the SPD manufacturer). The breaker shall be installed in the service entrance panel and shall be rated with the same electrical characteristics of the panel.
4. Protection modes and UL 1449 clamping voltage protection rating for ground wye circuits with voltages of 480Y/277 and 208Y/120, 3 phase, 4 wire shall be as follows:
   a) Line to Neutral: 1000V for 480Y/277 and 500V for 208Y/120.
5. All service entrance suppressors shall be manufactured by a single manufacturer
6. Approved manufacturers and model numbers:
   a) LEA International GB200 Series
   b) Liebert Interceptor SXXXY333 Series

c) Advanced Protection Technologies TE/xXGA/240 Series

7. Products shall bear the name of one specific manufacturer as listed above. Products that do not bear said name are not acceptable. If a product bears a different name due to a merger, acquisition, OEM arrangement or similar situation, said product is no longer acceptable.

C. Power Interruption:

1. During normal suppression operation, the unit shall not short circuit or crowbar the power flow that would result in an interruption to the load. Building power shall not require interruption for maintenance.

D. Distribution Panels and Lighting and Appliance Panelboard Suppressors:

1. Surge Protective Device Description: Non-modular type with the following features and accessories:

a) LED indicator lights for power and protection status.

2. Peak Single-Impulse Surge Current Rating: 80 ~~100~~ kA per phase.

3. Connection Means: Permanently wired through a 3 phase breaker (the size of the breaker shall be as recommended by the SPD manufacturer). The breaker shall be installed in the panelboard and shall be rated with the same electrical characteristics of the panelboard.

4. Protection modes and UL 1449 clamping voltage protection rating for grounded wye circuits with voltages of 480Y/277 and 208Y/120, 3 phase, 4 wire circuits shall be as follows:

a) Line to Neutral: 800V for 480Y/277 and 400V for 208Y/120.

b) Line to Ground: 800V for 480Y/277 and 400V for 208Y/120.

c) Neutral to Ground: 800V for 480Y/277 and 400V for 208Y/120.

5. All distribution panel and lighting and appliance panelboard suppressors shall be manufactured by a single manufacturer.

6. Approved manufacturers and model numbers:

a) Cooper Crouse-Hinds MTL, Inc.

b) LEA International SP100 Plus Series

c) Liebert ACVII Series

d) Advanced Protection Technologies TE/xXF Series

7. Products must bear the name of one specific manufacturer as listed above. Products that do not bear said name are not acceptable. If a product bears a different name due to a merger, acquisition, OEM arrangement or similar situation, said product is no longer acceptable.

E. Plug-in Receptacle Suppressors:

1. Instant automatic reset after safely eliminating transient surges from switching transients, induced lightning, inductive motor switching and other forms of transient over-voltages in normal mode (L-N) only.

2. Designed for 120 VAC, 1 phase (3 wire service), plug-in applications arranged to plug into any 20 amp, duplex grounded receptacle.

3. A minimum of two single or one duplex grounded 20 amp receptacle(s).

4. To be connected in parallel.

5. Employ only solid-state silicon avalanche junction diode suppressors or metal oxide varistors.
6. Response time less than 5 nanoseconds.
7. Suppression power: Minimum 12,000 watts or 12 joules. (10 x1000 μs pulse), at a maximum VDL of 300V peak.
8. Approved Manufacturers: LEA, Liebert, Leviton
9. Products must bear the name of one specific manufacturer as listed above. Products that do not bear said name are not acceptable. If a product bears a different name due to a merger, acquisition, OEM arrangement or similar situation, said product is no longer acceptable.

2.2 COMMUNICATIONS

A. Communication Lines: The following standard for separately mounted telephone and signal line suppressors shall apply. All protectors shall be securely mounted at protected equipment location. All suppressors shall provide common (L-G) and normal (L-L) protection. Suppressors shall be tested in accordance with IEEE C62.36 as a minimum. Protective interfacing with the telephone wire pairs shall be listed to UL 497A.

B. Data Line Protection: Solid state, silicon avalanche diode circuitry for protection from over voltages on long cable runs employing standard RS-232, 9, 15, or 25-pin "D" connectors utilized to interface a remote station with a host CPU. Unit shall have two built-in or ribbon cable attached connectors (in and out) and an external ground lug or cable. Connect ground lug or cable to CPU or terminal grounding system with a No. 12 copper green insulated stranded ground wire as short as possible. Select pins requiring protection based on protected equipment wiring requirements. Protectors shall be designed to be easily installed on multiplex panels with connector spacing at a minimum of 1.0 inch centers.

1. Signal line voltage (max.) 15V peak
2. Leakage at signal voltage <5 mA
3. Voltage protection level 16V peak
4. Response time 5 nanoseconds or less
5. Impedance per line 40 ohm max.
6. Peak power dissipation 15,000 watts (10/1000 Test Wave Form)
7. Temperature range -20°C to +65°C
8. Capacitance:
   a) Data rates <20,000 baud - <2,000 pf
   b) Data rates 20,000 baud to 2 MHz - <100 pf
   c) Data rates >2 MHz to 100 MHz - <40 pf
9. UL 497B listed.
10. See Section 27 26 26 Data Communications Integration Requirements for requirements for installations made by the Premise Distribution Wiring Contractor.
11. Approved Manufacturers: EDCO, Transtector, or Cooper Crouse-Hinds MTL.

C. Signal Line Protection (Telephone): Solid state, silicon avalanche diode circuitry for protection from over voltages on 2 or 4 wire signal lines such as balanced pair telephone, metallic pair telephone, buried and overhead field cable, remote radio equipment, and control systems. Unit shall have an external ground lug or wire. Connect ground lug or wire to protected equipment grounding system with a No. 12 green insulated stranded ground wire as short as possible. See Section 27 26 26 Data Communications Integration Requirements for requirements for installations made by the Premise Distribution Wiring Contractor

1. L-L & L-G Voltage (peak) L-L & L-G VPL
   13 16
   27 33

54	67
120	150
160	200

2. L-L and L-G Leakage @ max L-L and L-G voltage — <5 μA
3. Response time — <5 nanoseconds
4. Series impedance (each line) — 33 ohm max.
5. Peak power dissipation (L-L) or (L-G) — 15,000 watts (10 x 1000 Test Wave Form)
6. Temperature range — -20°C to +65°C
7. UL 497B listed
8. Approved Manufacturers: EDCO, Transtector, Atlantic Scientific

D. Modem Protector for Leased Lines: Solid-state silicon avalanche diode circuitry for non-faulting/non-interrupting protection from over voltages on leased phone lines. Full duplex protection shall be provided for both send and receive channels. Terminals shall be provided for 4-wire leased line input and output to equipment plus ground. Connect ground terminal to equipment ground. See Section 27 26 26 Data Communications Integration Requirements for requirements for installations made by the Premise Distribution Wiring Contractor.

1. Signal line voltage (max) — 160V peak
2. Leakage @ signal voltage — 5 μa
3. Clamp point — 200V peak
4. Response time — <5 nanoseconds.
5. Series impedance — 33 ohm max.
6. Peak power dissipation — 15,000 watts
7. Operating Temperature — -20°C to +65°C
8. Approved Manufacturers: EDCO, Transtector, Atlantic Scientific

E. Modular, Twisted Pair Protection: Solid state, silicon avalanche diode circuitry for protection from over voltages on twisted pair data or audio lines. Protectors shall clip mount on 66 punch down blocks furnished with grounding bar or studs and shall be totally enclosed. Units shall be securely mounted at terminal locations where shown and shall be grounded to the main building ground with a minimum No. 8 stranded copper green insulated ground conductor as short as possible. Terminals shall be screw insertion lug type. No crimp fork or ring type permitted. See Section 27 26 26 Data Communications Integration Requirements for requirements for installations made by the Premise Distribution Wiring Contractor.

1. Response time — <5 nanoseconds
2. Peak power dissipation (1ms) — 15,000 watts
3. Temperature range — -20° C to +50° C
4. Maximum voltage protection levels (peak) utilizing a 10 x 1000μs waveform for normal and common mode protection shall be 240-380V or 45V as indicated on the drawings.
5. Peak repetitive pulse current:
   a) 1 x 2 μs — 225 amp
   b) 8 x 20 μs — 150 amp
   c) 10 x 1000 μs — 100 amp
6. Approved Manufacturers: EDCO, Transtector, or Cooper Crouse-Hinds MTL.

F. 75 ohm Coaxial Cable Protectors: Solid state, silicon avalanche diode circuitry for non-interrupting over-voltage protection of RG- 59/U coaxial cable. Unit shall be provided with one female input connector for "F" series male connector, one output RG-59/U coax cable terminated with an "F" series male cable end connector and a #16 stranded, 18 inch long grounding wire on output end of unit or similar arrangement. Securely mount adjacent to protection equipment and ground to equipment or local building ground if an equipment ground is not available.

1. Normal Operating Characteristics:
   a) Voltage 5.8V max.
   b) Current 500 mA max.
   c) Frequency dc to 10 MHz
   d) Insertion Loss 3.5dB @ 4MHz

2. Protection Requirements:
   a) Transient suppression level 7.5v VPL
   b) Transient response <5 nanoseconds
   c) Operating temp -20^{o} C to $+50^{o}$ C
   d) Energy dissipation 15,000 watts (10X1000 Test Wave)

3. Approved Manufacturers: EDCO, Transtector, Atlantic Scientific

PART 3 - EXECUTION

3.1 SEGREGATION OF WIRING

A. General: All system wiring shall be classified into protected and non-protected categories. Wiring on the exposed side of suppression devices shall be considered unprotected. Surge suppressor grounding and bonding conductors shall also fall into this category.

B. Protection: All wiring between surge suppressors and protected equipment shall be considered protected and connected in accordance with the latest edition of the NEC.

C. Separation: A minimum of 3” of separation shall be provided between parallel runs of protected and unprotected wiring in control panel, terminal cabinets, terminal boards and other locations. In no case shall protected equipment and unprotected wiring be bundled together or routed through the same conduit. Where bundles of protected and unprotected wiring cross, such crossings shall be made at right angles.

3.2 INSTALLATION OF SURGE PROTECTIVE DEVICES

A. Installation at Service and Distribution Panels: Suppressors shall be installed at service entrance switchboards or switchgear as close as practical to distribution equipment to be protected consistent with the available space, however, do not exceed 3’. Where installation space permits and where no code restrictions apply, SPD may be installed within the distribution panel cabinet. SPD installed in this manner shall utilize the equipment chassis as a medium for bonding of their ground terminals. Bonding jumpers not exceeding 2” in length shall be installed between the chassis and suppressor ground terminals. Bolted connections with star washers shall be used to ensure electrical and mechanical integrity of connections to the equipment chassis. Conductors from SPD shall attach to main service bus connection in the service entrance equipment on the load side of the electrical utility company metering equipment.

B. Installation at Lighting and Appliance Panelboards: The SPD shall be installed as close as practical to the electrical panel or electronic equipment to be protected, consistent with available space. SPD shall be close-nippled to the device being protected in a position near the neutral bus, which will minimize lead length between the SPD and the buses and disconnect means to which the SPD connects. Pre-wired leads shall be field cut to minimize the length between panel connection point. SPD leads shall not extend beyond the suppressor manufacturer’s recommended maximum lead length without specific approval of the Engineer.

C. Location shown on Drawings is diagrammatic only. Provide flush mount trim for SPD units at flush mounted panelboards. Provide NEMA 4X enclosures for SPD units in exterior locations.

D. Workmanship: SPD shall be installed in a neat, workmanlike manner. Lead dress shall be consistent with recommended industry practices for the system on which these devices are installed.

3.3 TESTING:

A. Disconnect SPD via circuit breaker connection prior to meggar testing of service entrance.

END OF SECTION

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SECTION 26 51 13 – INTERIOR LIGHTING FIXTURES, LAMPS AND BALLASTS

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. Interior luminaires and accessories
2. Exit signs
3. Ballasts
4. Lamps
5. Luminaire accessories

B. Light fixtures furnished under this Division shall be furnished complete with lamps and all necessary trim and mounting hardware, and installed as shown on the drawings.

C. Light fixtures shall be neatly and firmly mounted, using standard supports for outlets and fixtures.

D. Lamps shall be included in the system guarantee for a period of thirty days after final acceptance of the building.

1.3 REFERENCES

A. ANSI C78.379 Classification of the Beam Patterns of Reflector Lamps

B. ANSI C82.1 Lamp Ballast – Line Frequency Fluorescent Lamp Ballast

C. ANSI C82.4 Ballasts for High-Intensity Discharge and Low Pressure Sodium Lamps (Multiple-Supply Type)

D. ANSI/NFPA 70 National Electrical Code

E. ANSI/NFPA 101 Life Safety Code

F. NEMA WD 6 Wiring Devices - Dimensional Requirements

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of:

1. ANSI/NFPA 70
2. NFPA 101
3. ADA

B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.2 SUBMITTALS

A. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

1. Shop drawings shall be submitted for all fixtures that require modifications, either as specified or as required to fit architectural field conditions of this project; (i.e., luminous ceiling, wall/slot fixtures, special fixtures).

2. Shop drawings shall be complete showing all dimensions and installation instructions required for conditions on this project.

B. Product Data: Provide dimensions, ratings, and performance data. Product data shall be

submitted for all light fixtures showing:

1. Dimensions
2. UL Label
3. Fusing
4. Metal gauge
5. Lens/louver thickness
6. Finish
7. Voltage
8. Lamps

1.3 OPERATION AND MAINTENANCE DATA

A. Submit Maintenance Data and include replacement parts list.

1.4 MANUFACTURER’S QUALIFICATIONS

A. Company specializing in manufacturing products specified in this Section with minimum five years experience.

1.5 PRODUCT STORAGE AND HANDLING

A. Physically protect fixtures against damage as recommended by manufacturer.

1.6 MAINTENANCE MATERIALS

A. Provide to Owner:

1. Ten of each size/type of fuses.
2. Six of each type of lamps.
3. One carton or twenty-four (whichever is greater) in manufacturer’s carton of 4’ T8 lamps.

1.7 WARRANTY

A. All ballasts furnished under this Division shall be covered by a warranty against defects. Warranty shall include payment for normal labor costs of replacement of inoperative in-warranty ballasts.

PART 2 - PRODUCTS

2.1 LUMINAIRES/FIXTURES

A. Furnish products as specified in schedule on Drawings.

B. Install ballasts, lamps, and specified accessories at factory.

C. All light fixtures shall adhere to UL Test Standard 1598 and NEC 410.115(C). All manufacturers shall provide the required thermal protection as required.

2.2 LAMPS

A. Manufacturers:

1. Osram Sylvania, GE, Phillips.

B. Incandescent:

1. Lamps to be rated and stamped for 130 volts.
2. Provide type specified for luminaire/fixture on drawings.
3. Reflector lamp beam patterns: ANSI C78.379.

C. Fluorescent:

1. Fluorescent lamps to be Octron type, T8 bulb with medium bi-pin base.
2. Correlated color temperature shall be 4100K with color rendering index of 80.

D. Compact Fluorescent:

1. General:
   a) Provide complete with starter, ballast, etc.
   b) Suitable for low starting temperatures 32 degrees F. and below.
2. Twin Tube Type:
   a) T4 bulb.
   b) 5, 7, 9, or 13 watt lamps as called for on Drawings.
   c) 4100K temperature.
   d) Color rendering index: 80.
3. Double Twin (quad) Tube Type:
   a) T4 bulb.
   b) 9, 13, 18 or 26 watt lamps as called of on Drawings.
   c) 4100K temperature.
   d) Color rendering index: 75.

2.3 BALLASTS

A. Manufacturers:

1. Magnetek, Advance, or accepted substitution.

B. Fluorescent Ballast:

1. Provide ballast suitable for lamps specified.
2. Voltage: Match luminaire voltage and voltage of system to which applied.
3. Ballast to be protected with in-line fuse/fuseholder.
4. Ballasts installed outdoors or in cool temperatures to be 0 degree ballasts.

C. Electronic Ballasts:

1. Fluorescent lamp ballasts shall be high frequency electronic type, operating lamps at a frequency of 20 kHz or higher with no detectable flicker.
2. Ballasts shall not be affected by lamp failure and shall yield normal lamp life.
3. Lamp current crest factor shall not exceed 1.6.
4. Ballasts shall operate at an input frequency of 60 Hz and an input voltage of 108 to 132 (120V models) or 249 to 305 (277V models).
5. Ballasts shall have power factor above 95 percent.
6. Ballasts that operate as a parallel circuit shall allow remaining lamp(s) to maintain full output if companion lamp(s) fail.
7. Ballasts shall carry five-year warranty, including labor allowance.
8. Ballast manufacturers shall have been producing electronic ballasts in the US for more than ten years with a low failure rate.
9. Ballasts shall be accepted and listed by Underwriters Laboratories.
10. Ballasts shall comply with all applicable state and federal efficiency standards.

11. Ballasts shall comply with FCC and NEMA limits governing electromagnetic and radio frequency interference and shall not interfere with operation of other normal electrical equipment.
12. Ballasts shall meet all applicable ANSI and IEEE standards regarding harmonic distortion and surge protection.
13. Total harmonic distortion (THD) to be less than 20 percent and shall have a passive power factor corrective front end.
14. Ballasts to be in 1, 2, 3 or 4-lamp configuration as required to facilitate switching/circuitry shown on or as called for on Drawings. If not specifically called for or noted on Drawings, provide minimum of one ballast per 2-lamp fixture, two ballasts per 3-lamp or 4-lamp fixture.

D. High Intensity Discharge (HID) Ballast:
1. Description: ANSI C82.4 high power factor type lamp ballast to match lamp.
2. Provide ballast suitable for lamp specified.
3. Voltage: Match luminaire voltage and system voltage to which applied.
4. Ballast to be protected with in-line fuse/fuseholder.

2.4 EXIT SIGNS

A. Description: Exit sign fixture suitable for use as emergency lighting unit.
B. Exit signs to have long life LED lamps for normal and emergency operation.
C. Exit sign shall have universal mount, universal arrows, down light, stencil face. Arrows shall be as shown on Drawings.
D. Transformer shall be dual rated for 120V or 277V.
E. Furnish all lamps required.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrate and supporting grids for luminaires.
B. Examine each luminaire to determine suitability for lamps specified.

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions and NEC.
B. Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.
C. Support luminaires larger than 2’ x 4’ size independent of ceiling framing.
D. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.
E. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prohibit movement.
F. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure.
G. Install recessed luminaires to permit removal from below.
H. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

I. Recessed luminaires not rated for contact with insulation (Type IC) shall not be installed within 3” of any insulation or as required by the NEC. All recessed luminaires installed within 3” of insulation shall be identified for contact with insulation and bear the UL Type IC label.

J. Install wall mounted luminaires and exit signs at height as indicated on Drawings, or as required by ADA, local codes and state codes. Where conflict exists between what is shown on Drawings and what is required by codes, install fixture as required by codes.

K. Install accessories furnished with each luminaire.

L. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

M. Bond products and metal accessories to branch circuit equipment grounding conductor.

N. Install specified lamps in each luminaire and exit sign.

O. Where ceiling mounted fixtures are called for in the Light Fixture Schedule and on the Drawings, this Contractor shall provide fixture trims and supports as required to match type of ceiling system which will be furnished. No ceiling fixtures shall be ordered until the Ceiling System Installer has given written acceptance of the method and location of fixture hanging and fixture type.

P. Fixtures supported by suspended ceiling systems shall be securely fastened to the ceiling framing member by mechanical means such as bolts, screws, or rivets. Ceiling framing members must be securely attached to each other and to the building structure as required by all applicable codes and standards.

Q. All interior and exterior light fixtures shall not have any labels exposed to normal viewing angles. This includes manufacturer’s labels and UL labels. All labels shall be concealed within the body of the fixture and/or luminaire. Manufacturer’s name or logo shall not appear on the exterior of any light fixture unless accepted in writing by the Engineer.

R. Miscellaneous (provide and install complete):

1. Low voltage transformers for all low voltage light fixtures.
2. Tents as required for fixtures in fire rated ceilings as per applicable codes.
3. Thermal protection for all fixtures with tents or fixtures surrounded by insulation as per applicable codes.
4. Zero degree ballast for outdoor lighting fixtures.
5. Heat removal or air supply slot covers for all fixtures requiring them as determined by Mechanical Engineer.

S. Ceiling surface mounted fluorescent fixtures installed in exposed ceiling areas are to be suspended from ceiling structure with minimum 3/8" all-thread rods and 1-1/2" x 1-1/2" Kindorf channels, full length of fixture/row. Mount outlet box at structure with flexible connection to fixture.

T. Coordinate fixtures installed in mechanical rooms with piping and ductwork prior to installation and relocate fixtures as required to provide proper illumination and access.

U. Electrical Contractor shall remotely locate all transformers called for in these Specifications in a well ventilated and easily accessible space to comply with all codes. Revise circuitry as shown on plans as required to facilitate transformer/fixture location.

V. Voltage for all fixtures shall match the voltage of the lighting circuit fixture is connected to. Coordinate with Electrical Drawings.

W. All light fixtures shall have label near lamp socket out of view of public stating maximum wattage of lamp allowed in fixture. Maximum wattage to be stated is wattage as shown on schedule of lighting equipment herein. Circuits are based on these wattages, circuitry, etc. Any failure to comply with this requirement shall be responsibility of Contractor. Location of labels must meet

acceptance of Lighting Designer, Architect and Engineer.

3.3 EXIT SIGNS

A. Install illuminated exit signs as shown on Drawings, as herein specified or as required by applicable codes.

B. Connect exit sign to local lighting circuit ahead of all switches.

C. Install suspended exit signs using pendant supported from swivel hangers.

D. Mount all exit signs at 7'-6" AFF or as required to meet ADA requirements. Provide all mounting and accessories/hardware as required for proper mounting including pendant/swivel hangers.

3.4 ADJUSTING

A. Aim and adjust luminaires as directed.

B. Adjust exit sign directional arrows as indicated.

C. Relamp luminaires that have failed lamps at Substantial Completion.

3.5 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosure.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

3.6 DEMONSTRATION

A. Provide demonstration of luminaire operation.

3.7 FIELD QUALITY CONTROL

A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.8 CLEAN-UP

A. Luminaires:

1. Clean free from dust and dirt. Wash lens and glassware using cleaner such as Windex and dry with absorbent paper. Clean plastic per manufacturer's recommendations; do not wipe. Lenses which are kept in original containers until immediately prior to final inspection may not require cleaning. Clean Alzak aluminum surfaces (reflectors, fixture cones) per manufacturer's recommendations being careful to remove finger prints and smudges.
2. It is the Contractor's responsibility to remove any UL labels or manufacturers labels from areas of fixture exposed to view and relocate label to non-obtrusive area on fixture.

END OF SECTION

SECTION 26 52 13 - EMERGENCY LIGHTING EQUIPMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:

1. Emergency lighting units.
2. Emergency exit signs.
3. Emergency fluorescent lamp power supplies.

1.3 REFERENCES

A. Americans with Disabilities Act of 1990 (ADA)

B. ANSI C78.379 Classification of the Beam Patterns of Reflector Lamps

C. ANSI C82.1 Lamp Ballast – Line Frequency Fluorescent Lamp Ballast

D. ANSI/NFPA 70 National Electrical Code

E. Florida Building Code (FBC)

F. Fed. Spec. W-L-305D Light Set, General Illumination (Emergency or Auxiliary)

G. NFPA 101 Life Safety Code

H. NEMA WD 1 General Requirements for Wiring Devices

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of:

1. ADA
2. ANSI/NFPA 70
3. FBC
4. NFPA 101

B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.5 DESCRIPTION

A. Emergency lighting fixtures furnished under this Division shall be furnished complete with lamps and all necessary trim and mounting hardware, and installed per manufacturer's instructions as shown on the Drawings.

B. Light fixtures shall be neatly and firmly mounted using standard supports for outlets and fixtures.

C. Lamps shall be included in the system guarantee for a period of thirty days after final acceptance of the building.

D. The use of a fixture that emits an alarm sound when the unit has a fault is not acceptable.

1.6 SUBMITTALS DURING CONSTRUCTION

A. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

1. Shop drawings shall be submitted for all fixtures that require modifications either as specified or as required to fit architectural field conditions of this project (i.e., specialty exit signs).

2. Shop drawings shall be complete showing all dimensions and installation instructions required for conditions on this project.

B. Product Data: Provide dimensions, ratings, and performance data. Product data shall be submitted for all fixtures showing:

1. Dimensions
2. UL label
3. Fusing
4. Metal gauge
5. Lens/louver thickness
6. Finish
7. Voltage
8. Lamps
9. Batteries

1.7 OPERATION AND MAINTENANCE DATA

A. Submit maintenance data including replacement parts list.

1.8 MANUFACTURER’S QUALIFICATIONS

A. Company specializing in manufacturing products specified in this Section with minimum five years experience.

1.9 PRODUCT STORAGE AND HANDLING

A. Physically protect fixtures against damage as recommended by manufacturer.

1.10 MAINTENANCE MATERIALS

A. Provide to Owner:

1. Ten of each size/type of fuses.

2. Six of each type of lamps.

1.11 WARRANTY

A. All ballasts furnished under this Division shall be covered by a warranty against defects. Warranty shall include payment for normal labor costs of replacement of inoperative in-warranty ballasts.

PART 2 - PRODUCTS

2.1 LUMINAIRES/FIXTURES

A. Furnish products as specified in schedule on Drawings.

B. Ballasts, lamps and specified accessories are to be factory installed.

C. All light fixtures shall adhere to UL Test Standards 1598, 924 and NEC 410.115(C). All manufacturers shall provide the required thermal protection as required.

2.2 SELF-CONTAINED EMERGENCY POWER EXIT SIGNS

A. Type: Exit signs with integral battery-operated emergency power supply, including power failure relay, test switch, AC ON pilot light, battery, and fully-automatic two-rate charger.

B. Battery: Sealed nickel cadmium cell, requiring no maintenance or replacement for ten years under normal conditions. Batteries to have a nine year warranty, and provide for ninety minute

capacity.

C. Exit sign fixture shall be suitable for use as emergency lighting unit.

D. Exit sign shall be die-cast with universal mount, universal arrows, down light, stencil face. Arrows shall be as shown on Drawings.

E. Exit signs to have long life LED lamps for normal and emergency operation, integral battery, battery charger, transformer, test switch, and LED charge monitor light.

F. Transformer shall be dual rated for 120 or 277 volts.

G. Furnish all lamps required.

H. Charger shall comply with UL 924.

2.3 INCANDESCENT EMERGENCY LIGHTING UNITS

A. Self-contained emergency lighting unit.

B. Battery: 6 volt nickel cadmium type with 1.5 hour capacity.

C. Battery Charger: Dual-rate type with sufficient capacity to recharge discharged battery to full charge within twelve hours.

D. Lamps: 9 watt minimum.

E. Remote Lamps: Match lamps on unit.

F. Housing: As called for on Drawings.

G. Indicators: Provide lamps to indicate AC ON and RECHARGING.

H. Provide TEST switch to transfer unit from external power supply to integral battery supply.

I. Electrical Connection: Conduit connection.

J. Input Voltage: To match applied circuit voltage.

2.4 FLUORESCENT LAMP EMERGENCY POWER SUPPLY

A. Manufacturers:

1. Bodine Model B50 Series
2. Chloride Model CFP60 Series
3. Prescolite Model EFP5 Series
4. Lithonia PS1100 Series
5. Lightolier FBP50

B. Description: Emergency battery power supply suitable for installation in ballast compartment of fluorescent luminaire.

C. Lamp Ratings: One or two FO32 T8 lamps providing a total of 900-1100 lumens, for ninety minutes minimum.

D. Battery: Sealed nickel cadmium type, rated for seven year life.

E. Include TEST switch and AC ON indicator light, installed to be operable and visible from the outside of an assembled luminaire.

F. Inverter/charger unit shall be completely solid state with automatic transfer in case of power failure and automatic cutout to prevent deep discharge of batteries. Recharge time shall be twenty-four hours maximum.

G. Units to be installed in fixtures utilizing energy saving lamps and/or ballast shall be a type

compatible for use with this equipment.

H. Connect unit to local lighting circuit ahead of all switches. Provide and install wiring to accomplish this.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units plumb and level.

B. Aim directional lampheads as directed.

C. Adjust units as required to align with building lines and with each other. Secure to prohibit movement.

D. Adjust exit sign directional arrows as indicated. Readjust at project completion as required by Authority Having Jurisdiction.

E. Install illuminated exit signs as shown on Drawings, as herein specified, or as required by applicable codes.

F. Connect exit signs, inverter/battery units to local lighting circuit ahead of all switches.

G. Install suspended exit signs using pendants supported from swivel hangers.

H. Mount all exit signs at 7'-6" AFF to bottom of fixture or as required to meet ADA requirements. Provide all mounting accessories/hardware as required for proper mounting including pendant/swivel hangers.

I. Evenly space all emergency egress lighting units and provide proper lumen output of units as required to provide lighting levels and uniformity ratios required by applicable codes.

1. FBC Section 1006.2.3.1 Emergency lighting facilities shall be arranged to provide initial illumination that is at least an average of 1 footcandle and a minimum at ay point of 0.1 footcandle measured along the path of egress at floor level. Illumination levels shall be permitted to decline to 0.6 footcandle average and a minimum at any point of 0.06 footcandle at the end of the emergency lighting time duration. A maximum-to-minimum illumination uniformity ratio of 40:1 shall not be exceeded.

END OF SECTION

26 56 00 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:

1. Exterior luminaires and accessories
2. Poles

B. Light fixtures furnished under this Division shall be furnished complete with lamps and all necessary trim and mounting hardware, and installed as shown on the drawings.

C. Light fixtures shall be neatly and firmly mounted.

D. Lamps shall be included in the system guarantee for a period of thirty days after final acceptance of the project.

E. Provide and install concrete base as noted on drawings. Construct concrete base per applicable section and/or division of the specifications.

1.3 REFERENCES

A. ANSI C78.379 Classification of the Beam Patterns of Reflector Lamps

B. ANSI C82.1 For Lamp Ballast – Line Frequency Fluorescent Lamp Ballast

C. ANSI C82.4 Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)

D. ANSI O5.1 Wood Poles, Specifications and Dimensions

E. ANSI/NFPA 70 National Electrical Code

F. ASCE 7-10 Minimum Design Loads for Buildings and Other Structures

G. IES RP-8 Roadway Lighting

H. IES RP-20 Lighting for Parking Facilities

1.4 REGULATORY REQUIREMENTS

A. Conform to the requirements of the following:

1. ANSI/NFPA 70 National Electrical Code
2. ASCE 7-10 Minimum Design Loads for Buildings and Other Structures
3. FBC Florida Building Code
4. IES Illuminating Engineering Society
5. NESC National Electrical Safety Code
6. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.5 SUBMITTALS

A. Submit point to point photometric analysis of the entire job site to the property line. Utilize photometric data obtained from submitted fixtures only. Verify that all submitted fixture types and

light levels are compliant with all local codes, ordinances, and the Authority Having Jurisdiction. Submittal will not be reviewed by the A/E without this narrative data.

B. Provide light levels in accordance with the current edition of the IES Handbook, current edition, for parking area lighting.

C. Provide for separate time-clock control for turning off of 50 percent of the parking area fixtures after a time determined by Owner to provide only security lighting.

D. Product Data: Provide dimensions, ratings, and performance data. Product data shall be submitted for all light fixtures showing:

1. Dimensions
2. UL label
3. Fusing
4. Luminaire disconnect
5. Metal gauge
6. Lens thickness
7. Finish
8. Voltage
9. Lamps
10. Lightning arrestor, surge arrestor/and/or surge protection device

E. Submit drawings on concrete base complete with rebars, etc.

1.6 PROJECT RECORD DOCUMENTS

A. Submit record documents to accurately record actual locations of each luminaire.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit Maintenance Data and include instructions for maintaining luminaires.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and protect products at site.

B. Accept products on site. Inspect for damage.

C. Protect poles from finish damage by handling carefully.

D. Store and handle solid wood poles in accordance with ANSI O5.1.

1.10 COORDINATION

A. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish a complete fixture schedule of all fixtures used on the drawings, including full fixture description, catalog number, number of lamps, wattage, and voltage. Provide a minimum of three acceptable manufacturers for each luminaire/fixture. Sole sourcing will not be allowed.

B. All lighting fixtures mounted outdoors subject to dampness and insects shall have gasketing material between lens door and frame to completely seal interior of fixture. Knockouts and holes in fixtures housing shall be closed and sealed. All fixtures shall be complete with lamps, shielding, brackets, concrete bases, anchor bolts and all necessary fittings and accessories for a complete installation.

C. Furnish products as specified on drawings.

D. All exterior light fixtures shall not have any labels exposed to normal viewing angles. This includes manufacturer labels and UL labels. All labels shall be concealed within the body of the fixture and/or luminaire. No manufacturers name or logo shall appear on the exterior of any light fixtures unless accepted in writing by the Engineer.

E. All light fixtures shall adhere to UL Test Standard #1598 and NEC 410.115(C). All manufacturers shall provide the required thermal protection as required.

F. Pole luminaires, poles, and concrete bases shall comply with applicable requirements of IES, NESC, ASCE and FBC, including, but not limited to their requirements for illumination, uniformity, construction, wind loading, pole setback, breakaway, installation, glare criteria.

G. All site lighting fixtures/luminaries that may spill light onto adjacent properties shall have glare control shield installed on all fixtures/luminaries as required to meet the glare control requirements of applicable codes and standards. Add required glare control shield to order/model number of all site lighting fixtures.

2.2 BALLASTS

A. Fluorescent Ballast:

1. Description: ANSI C82.1 electronic ballast rated for 0 degrees F.
2. Provide ballast suitable for lamps specified.
3. Voltage: Match luminaire voltage and voltage of system to which applied.
4. Source Quality Control: Certify ballast design and construction by Certified Ballast Manufacturers, Inc.
5. Ballast to be protected with in-line fuse/fuseholder.
6. Provide disconnecting means for ballast that simultaneously disconnects all supply conductors to the ballast, including the ground conductor.

B. High Intensity Discharge (HID) Ballast:

1. Description: ANSI C82.4 lamp ballast to match lamp.
2. Provide ballast suitable for lamp specified.
3. Voltage: Match luminaire voltage and voltage of system to which applied.
4. Ballast to be protected with in-line fuse/fuseholder.

2.3 LAMPS

A. Provide lamp type specified for luminaire.

B. All lamps shall match those specified in Section 26 51 13 Interior Lighting Fixtures, Lamps and Ballasts.

C. Lamps shall be metal halide or fluorescent.

2.4 LIGHTNING ARRESTOR

A. Provide lightning arrestor for each pole light.

B. Lightning arrestor to be UL listed.

C. All new construction and retrofit shall install Pulse Arc technology for HID ballast.

D. Lightning arrestors/SPD devices shall be mounted next to the lighting contactor in electrical rooms serving exterior lighting fixtures. All circuits are to be protected with lightning arrestors/SPD devices.

2.5 LED FIXTURES

A. All LEDs used in the LED fixture shall be high brightness and of proven quality from established and reputable LED manufacturers.

B. Manufacturer shall utilize an advanced production LED binning process such as Optibin® consistency from fixture to fixture and project to project over time, while ensuring a reliable supply of LEDs from the supplier.

C. LED fixtures shall meet lumen maintenance standards as defined in IESNA LM-80-08.

D. Manufacturer shall provide optical performance, polar diagrams, and photometric data in various formats, including IES file format in accordance with IES LM-79-08.

E. Photometric data shall be based on test results from an independent NIST traceable testing lab. IES data must be available and downloadable from manufacturer’s web site.

F. The luminaire shall contain complete prewired integral drivers and an optical assembly that shall provide a distribution of footcandle that is consistent with FBC.

G. Labeling shall be in accordance with ANSI standards. All units shall be UL labeled.

H. The luminaire shall meet ANSI 2G vibration standards.

I. The drivers shall be UL Class II and operated in constant current mode. The drivers shall be prewired to the light engine. The light engine assembly and housing shall be of the same manufacturer. The driver shall start and operate the light engine at ambient temperatures from 0 degrees to 50 degrees Celsius.

J. The system must survive 120 repetitive strikes of B2 waveforms (IEEE/ANSI C62.41.1 1991 scenario one location category, at one minute intervals with less than 10 percent degradation in clamping voltage.

K. The light engine assembly shall consist of a precision die cast aluminum heat sink, metal core printed circuit board assembly, a precision formed optical assembly comprised of injection molded high specular reflectors. The light engine assembly shall use high brightness emitting diodes with average CCT of 6000K and CRI greater than 65.

L. Manufacturer shall provide a five year warranty from date of substantial completion.

M. Test shall be performed to verify lumen output, life and color properties, CCT and CRI and shall be tested and measured in accordance with LM-80. Lumens depreciation shall be in accordance with LM-80. Lumen maintenance projections shall not exceed 6X of the available system-level lumen depreciation test data. The system shall be rated at L70/B50 for not less than 50,000 hours.

N. Manufacturer (other than the basis of design) shall provide revised photometrics for all areas to prove equal or greater photometric equivalency of the proposed LED luminaires. If additional luminaires are required, manufacturer will be responsible for all additional cost for the redesign or reconfiguration of the space.

2.6 FINISHES

A. Aluminum Finishes: Powder coat.

B. Powder-Cote Finish: Manufacturer’s standard powder-coat finish consisting of primer and topcoat according to coating manufacturer’s written instructions for cleaning, pretreatment, application, thermosetting, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine excavation and concrete foundation for lighting poles.

B. Examine each luminaire to determine suitability for lamps specified.

3.2 INSTALLATION

A. Install all fixtures in accordance with manufacturers written instructions, NEC, IES, ASCE, FBC, and NESC.

B. Install lighting poles at locations indicated.

C. Install poles plumb. Provide double nuts to adjust plumb. Grout around each base.

D. Anchoring Criteria: Provide for anchoring of poles, either on drawings or via a requirement for submittal of and compliance with engineering report(s) during construction.

E. Install lamps in each luminaire.

F. Bond luminaires, metal accessories and metal poles to branch circuit equipment grounding conductor. Provide supplementary grounding electrodes at each pole. See Section 26 05 26 Grounding and Bonding.

G. Where ceiling mounted fixtures are called for in the Light Fixture Schedule and on the drawings, this Contractor shall provide fixture trims and supports as required to match type of ceiling system which will be furnished. No ceiling fixtures shall be ordered until the Ceiling System Installer has given written acceptance of the method and location of fixture hanging and fixture type. Fixtures supported by suspended ceiling systems shall be securely fastened to the ceiling framing member by mechanical means, such as bolts, screws, or rivets. Clips identified for use with the type of ceiling framing member(s) and fixture(s) shall also be permitted.

H. All exterior post/pole mounted light fixtures shall have hand hole near base. Hand hole shall provide easy access to light fixture fusing and lightning protection ground lug. Lightning protection ground lug shall be provided inside post/pole, electrically in contact with pole, for connection to ground rod. Provide and install ground wire from ground lug to ground rod, concealing ground wire through post/pole base. Anchor bolts to be galvanized.

I. Pole installation shall comply with windloading criteria stated in ASCE 7-10 and Florida Building Code. Use V velocity = 140 mph; Category II, Exposure B, and the formulas and tables presented in ASCE 7-10.

J. Provide soil compacting and/or treatment to assure windloading can be achieved for direct buried poles.

K. Ducseal shall be installed to seal all conduits entering exterior light fixtures from underground.

L. In-line fusing shall be located at handhole location of pole for easy access.

M. Verify all fluorescent fixtures have a luminaire disconnect. Provide luminaire disconnect in any luminaries where factory failed to install luminaire disconnect.

3.3 FIELD QUALITY CONTROL

A. Operate each luminaire after installation and connection. Inspect for improper connections and operation.

3.4 ADJUSTING

A. Aim and adjust luminaires to provide illumination levels and distribution as directed.

B. Re-lamp luminaires which have failed lamps at date of Substantial Completion.

3.5 GLARE CONTROL

A. Provide, install and adjust glare control shields to prevent light glare on adjacent properties.

3.6 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosure.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

E. Luminaires:

1. Clean free from dust and dirt. Wash lens and glassware using cleaner such as "Windex" and dry with absorbent paper. Clean plastic per manufacturer's recommendations; do not wipe. Lenses which are kept in original containers until immediately prior to final inspection may not require cleaning. Clean "Alzak" aluminum surfaces (reflectors, fixture cones and the like) per manufacturer's recommendations being careful to remove fingerprints and smudges.

2. It is the Contractor's responsibility to remove any UL labels or manufacturer’s labels from areas of fixture exposed to view and relocate label to non-obtrusive area on fixture.

3.7 DEMONSTRATION

A. Provide for training of school personnel in the setting and operation of lighting controls.

END OF SECTION

SECTION 26 56 68 – EXTERIOR ATHLETIC LIGHTING

PART 1- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Work covered by this Section of the Specifications shall conform to the Contract Documents, Engineering Plans as well as state and local codes.

B. The purpose of these Specifications is to define the performance and design standards. The manufacturer/contractor shall supply lighting equipment to meet or exceed the standards set forth by the criteria set forth in these Specifications.

C. The sports lighting will be for the following fields:

1. Football Field
2. Track
3. Soccer Field

D. The primary goals of this sports lighting project are:

1. Life Cycle Cost: In order to reduce the operating budget, the preferred lighting system shall be energy efficient and cost effective to operate. All maintenance costs shall be eliminated, and the field(s) should be proactively monitored to detect fixture outages over a twenty-five year life cycle. To allow for optimized use of labor resources and avoid unneeded operation of the facility, customer requires a remote on/off control system for the lighting system.
2. Guaranteed Light Levels: Selection of appropriate light levels impact the safety of the players and the enjoyment of spectators. Therefore, the lighting system shall be designed such that the light levels are guaranteed for a period of twenty-five years.

1.3 LIGHTING PERFORMANCE

A. Performance Requirements: Playing surfaces shall be lit to an average constant light level and uniformity as specified in the chart below. Light levels shall be held constant for twenty-five years. Lighting calculations shall be developed and field measurements taken on the grid spacing with the minimum number of grid points specified below. Measured average illumination level shall be +/- 10 percent of predicted mean in accordance with IESNA RP-6-01, and measured at the first 100 hours of operation.

Area of Lighting	Average Constant Light Levels	Maximum to Minimum Uniformity Ratio	Grid Points	Grid Spacing
Football Field	50 footcandles	2.0:1.0	72	30’ x 30’
Track	20 footcandles	16.0:1.0	52	30’ x 30’
Soccer	30 footcandles	2.0:1.0	72	30’ x 30’

1.4 ENVIRONMENTAL LIGHT CONTROL

A. Spill Light Control: Maximum horizontal footcandles at the property line shall not exceed .5. Maximum horizontal footcandles at the school field shall not exceed 1.2. Measured average illumination level shall allow a 10 percent variance of predicted mean in accordance with IESNA RP-6-01, and be measured at the first 100 hours of operation.

1.5 LIFE CYCLE COSTS

A. Energy Consumption: The average kWh consumption for the field lighting system shall be 108.8 or less for the football field, 108.8 or less for the track.

B. Complete Lamp Replacement: Manufacturer shall include all group lamp replacements required to provide twenty-five years of operation based upon 350 usage hours per year.

C. Preventative and Spot Maintenance: Manufacturer shall provide all preventative and spot maintenance, including parts and labor for twenty-five years from the date of equipment shipment. Individual lamp outages shall be repaired when the usage of any field is materially impacted. Owner agrees to check fuses in the event of a luminaire outage.

D. Remote Monitoring System: System shall monitor lighting performance and notify manufacturer if individual luminaire outage is detected so that appropriate maintenance can be scheduled. The manufacturer shall notify the owner of outages within 24 hours, or the next business day. The controller shall determine switch position (Manual or Auto) and contactor status (open or closed).

E. Remote Lighting Control System: System shall allow Owner and users with a security code to schedule on/off system operation via a web site, phone, fax or email up to ten years in advance. Manufacturer shall provide and maintain a two-way TCP/IP communication link. Trained staff shall be available 24/7 to provide scheduling support and assist with reporting needs.

F. The Owner may assign various security levels to schedulers by function and/or fields. This function must be flexible to allow a range of privileges such as full scheduling capabilities for all fields, to only having permission to execute “early off” commands by phone.

G. Controller shall accept and store 7-day schedules, be protected against memory loss during power outages, and shall reboot once power is regained and execute any commands that would have occurred during outage.

H. Management Tools: Manufacturer shall provide a web-based database of actual field usage and provide reports by facility and user group.

I. Communication Costs: Manufacturer shall include communication costs for operating the controls and monitoring system for a period of twenty-five years.

J. Twenty-five-Year Life Cycle Cost: Manufacturer shall submit twenty-five year life cycle cost calculations as follows. Equipment price and total life cycle cost shall be entered separately on bid form.

a.	**Luminaire energy consumption** # luminaires x __kW demand per luminaire x $.11 kW rate x 350 annual usage hours x twenty-five years		
b.	**Cost for spot relamping and maintenance over twenty-five years** Assume 7.5 repairs at $ 500 each if not included	+	
c.	**Cost to relamp all luminaires during twenty-five years** 350 annual usage hours x twenty-five years / lamp replacement hours (____) x $125 lamp & labor x # fixtures	+	
d.	**Extra energy used without base bid automated control system** $ Energy consumption in item a. x 5%.	+	
	TOTAL Twenty-Five Year Life Cycle Operating Cost	=	

1.6 WARRANTY AND GUARANTEE

A. Twenty-Five Year Warranty: Each manufacturer shall supply a signed warranty covering the entire system for twenty-five years. Warranty shall guarantee light levels, lamp replacements, system energy consumption, monitoring, maintenance and control services, spill light control, and structural integrity. Manufacturer shall maintain specifically-funded financial reserves to assure fulfillment of the warranty for the full term. Warranty may exclude fuses, storm damage, vandalism, abuse and unauthorized repairs or alterations.

1.7 DELIVERY TIMING

A. Equipment On-Site: The equipment must be on-site four to six weeks from receipt of approved submittals and receipt of complete order information.

1.8 PRE-BID SUBMITTAL REQUIREMENTS

A. Approved Product: Musco’s Light-Structure Green™ System is the approved product. All substitutions must provide a complete submittal package for approval as outlined in Submittal Information at the end of this section at least ten days prior to bid. Special manufacturing to meet the standards of this specification may be required. An addendum will be issued prior to bid listing any other approved lighting manufacturers and designs.

B. Design Approval: The Owner/Engineer will review pre-bid shop drawings from the manufacturers to ensure compliance to the specification. If the design meets the design requirements of the specifications, a letter will be issued to the manufacturer indicating approval for the specific design submitted.

1.9 ALTERNATE SYSTEM REQUIREMENTS

A. Compliance to Specifications: Acceptance of a bid alternate does not negate the contractor and lighting manufacturer’s responsibility to comply fully with the requirements of these specifications. Any exceptions to the specifications must be clearly stated in the prior approval submittal documents.

B. Lamps shall be 1500 watt metal halide and shall be manufactured by GE, Philips, or Sylvania. No high output lamps shall be used, and no other type of lamps will be considered. Horizontal arc tube designs will not be considered. Manufacturer shall supply computer generated point-by-point light scans based on 155,000 lumens per lamp.

C. Light Level Requirements: Manufacturer shall provide computer models guaranteeing light levels on the field over twenty-five years. If a constant light level cannot be provided, a

maximum Recoverable Light Loss Factor of 0.70 shall be applied to the initial light level design to achieve the maintained light levels of 50 footcandles for the Football field, 25 footcandles for the Track. For alternate systems, scans for both initial and maintained light levels shall be submitted.

D. Revised Electrical Distribution: Manufacturer shall provide revised electrical distribution plans to include changes to service entrance, panel and wire sizing.

PART 2 - PRODUCT

2.1 LIGHTING SYSTEM CONSTRUCTION

A. System Description: Lighting system shall consist of the following:

1. Galvanized steel poles and crossarm assembly.
2. Pre-stressed concrete base embedded in concrete backfill.
3. All luminaires shall be constructed with a die-cast aluminum housing to protect the luminaire reflector system.
4. Manufacturer will remote all ballasts and supporting electrical equipment in aluminum enclosures mounted approximately 10’ above grade. The enclosures shall include ballast, capacitor and fusing for each luminaire. Safety disconnect per circuit for each pole structure will be located in the enclosure.
5. Wire harness complete with an abrasion protection sleeve, strain relief and plug-in connections for fast, trouble-free installation.
6. Controls and Monitoring Cabinet to provide on-off control and monitoring of the lighting system, constructed of NEMA Type 4 aluminum. Communication method shall be provided by manufacturer. Cabinet shall contain custom configured contactor modules for 30, 60, and 100 amps, labeled to match field diagrams and electrical design. Manual Off-On-Auto selector switches shall be provided.

B. Manufacturing Requirements: All components shall be designed and manufactured as a system. All luminaires, wire harnesses, ballast and other enclosures shall be factory assembled, aimed, wired and tested.

C. Durability: All exposed components shall be constructed of corrosion resistant material and/or coated to help prevent corrosion. All exposed steel shall be hot dip galvanized per ASTM A123. All exposed hardware and fasteners shall be stainless steel of at least 18-8 grade, passivated and polymer coated to prevent possible galvanic corrosion to adjoining metals. All exposed aluminum shall be powder coated with high performance polyester. All exterior reflective inserts shall be anodized, coated with a clear, high gloss, durable fluorocarbon, and protected from direct environmental exposure to prevent reflective degradation or corrosion. All wiring shall be enclosed within the crossarms, pole, or electrical components enclosure.

D. Lightning Protection: All structures shall be equipped with lightning protection meeting NFPA 780 standards. Contractor shall supply and install a ground rod of not less than 5/8” in diameter and 8’ in length, with a minimum of 10’ embedment. Ground rod should be connected to the structure by a copper main down conductor with a minimum size of #2 for poles with less than 75’ mounting height and 2/0 for poles with more than 75’ mounting height.

E. Safety: All system components shall be UL Listed for the appropriate application.

F. Electric Power Requirements for the Sports Lighting Equipment:

1. Electric power: 480 Volt, 3 Phase
2. Maximum total voltage drop: Voltage drop to the disconnect switch located on the poles shall not exceed 3 percent of the rated voltage.

2.2 STRUCTURAL PARAMETERS

A. Support Structure Wind Load Strength: Poles and other support structures, brackets, arms, bases, anchorages and foundations shall be determined based on the 2008 edition of the Florida Building Code, wind speed of 110 mph, exposure category C and an importance factor of 1.15. Luminaire, visor, and crossarm shall withstand 150 mph winds and maintain luminaire aiming alignment.

B. Structural Design: The stress analysis and safety factor of the poles shall conform to AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.

C. Soil Conditions: The design criteria for these specifications are based on soil design parameters as outlined in the geotechnical report. If a geotechnical report is not provided by the Owner, the foundation design shall be based on soils that meet or exceed those of a Class 5 material as defined by 2001 IBC, Table 1804.2-I-A OR 1997 UBC, Table 18-I-A.

D. Foundation Drawings: Project specific foundation drawings stamped by a registered engineer in the state where the project is located are required. The foundation drawings must list the moment, shear (horizontal) force, and axial (vertical) force at ground level for each pole. These drawings must be submitted at time of bid to allow for accurate pricing.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Illumination Measurements: Upon substantial completion of the project and in the presence of the Contractor, Project Engineer, Owner's Representative, and Manufacturer's Representative, illumination measurements shall be taken and verified. The illumination measurements shall be conducted in accordance with IESNA RP-6-01, Appendix B.

B. Correcting Non-Conformance: If, in the opinion of the Owner or his appointed Representative, the actual performance levels including footcandles, uniformity ratios, and maximum kilowatt consumptions are not in conformance with the requirements of the performance specifications and submitted information, the manufacturer or Contractor shall be liable to any or all of the following:

C. Manufacturer or Contractor shall at his expense provide and install any necessary additional fixtures to meet the minimum lighting standards. The Manufacturer or Contractor shall also either replace the existing poles to meet the new wind load (EPA) requirements or verify by certification by a licensed structural engineer that the existing poles will withstand the additional wind load.

D. Manufacturer or Contractor shall minimize the Owner's additional long term fixture maintenance and energy consumption costs created by the additional fixtures by reimbursing the Owner the amount of $1,000.00 (one thousand dollars) for each additional fixture required.

E. Manufacturer or Contractor shall remove the entire unacceptable lighting system and install a new lighting system to meet the specifications.

SUBMITTAL INFORMATION

Design Submittal Data Checklist and Certification

All items listed below are mandatory, shall comply with the specification and be submitted according to pre-bid submittal requirements

Included	Tab	Item	Description
	A	Letter/ Checklist	Listing of all information being submitted must be included on the table of contents. List the name of the manufacturer's local representative and his/her phone number. Signed submittal checklist to be included.
	B	On Field Lighting Design	Lighting design drawing(s) showing: a. Field Name, date, file number, prepared by, and other pertinent data b. Outline of field(s) being lighted, as well as pole locations referenced to the center of the field (x & y), or homeplate for baseball/softball fields. Illuminance levels at grid spacing specified c. Pole height, number of fixtures per pole, as well as luminaire information including wattage, lumens and optics d. Height of meter above field surface e. Summary table showing the number and spacing of grid points; average, minimum and maximum illuminance levels in foot candles (fc); uniformity including maximum to minimum ratio, coefficient of variance and uniformity gradient; number of luminaries, total kilowatts, average tilt factor; light loss factor. f. Alternate manufacturers shall provide both initial and maintained light scans using a maximum 0.70 Light Loss Factor to calculate maintained values.
	C	Off Field Lighting Design	Lighting design drawings showing spill light levels in footcandles as specified in paragraph Environmental Light Control.
	D	Life Cycle Cost calculation	Document life cycle cost calculations as defined in the specification. Identify energy costs for operating the luminaires, maintenance cost for the system including spot lamp replacement, and group relamping costs. All costs should be based on twenty-five years.
	E	Luminaire Aiming Summary	Document showing each luminaire's aiming angle and the poles on which the luminaries are mounted. Each aiming point shall identify the type of luminaire.
	F	Structural Calculations	Pole structural calculations and foundation design showing foundation shape, depth backfill requirements, rebar and anchor bolts (if required). Pole base reaction forces shall be shown on the foundation drawing along with soil bearing pressures. Design must be stamped by a structural engineer in the state of Florida.
	G	Control and Monitoring	Manufacturer shall provide written definition and schematics for automated control system to include monitoring. They will also provide examples of system reporting and access for numbers for personal contact to operate the system.
	H	Electrical distribution plans	If bidding an alternate system, manufacturer must include a revised electrical distribution plan including changes to service entrance, panels and wire sizing, signed by a licensed Electrical Engineer in the state of Florida.
	I	Performance Guarantee	Provide performance guarantee including a written commitment to undertake all corrections required to meet the performance requirements noted in these specifications at no expense to the owner. Light levels must be guaranteed per specification for twenty-five years.
	J	Warranty	Provide written warranty information including all terms and conditions.
	K	Project References	Manufacturer to provide a list of project references of similar products completed within the past three years.
	L	Product Information	Complete set of product brochures for all components, including a complete parts list and UL Listings.
	M	Non-Compliance	Manufacturer shall list all items that do not comply with the specifications.
	N	Compliance	Manufacturer shall sign off that all requirements of the specifications have been met at that the manufacturer will be responsible for any future costs incurred to bring their equipment into compliance for all items not meeting specifications and not listed in item N – Non-Compliance

Manufacturer: _____ **Signature:** _____

Contact Name: _____ **Date:** _____/_____/_____

Division 27

Communications

SECTION 27 41 31 – LOCAL AREA SOUND SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions, Division 01 Specification Sections and applicable sections of Divisions 26, 27 28 apply to this section.

1.2 GENERAL

A. The work described herein and on the drawings consists of all labor, materials, equipment, and services necessary and required to provide and test a Local Area Sound System(s) (hereinafter referred to as "system" or "sound system). Any material not specifically mentioned in this specification or not shown on the drawings but required for proper performance and operation shall be provided.

B. The drawings and specifications herein comply to the best of the Engineer's knowledge with all applicable codes at the time of design. However, it is this Contractor's responsibility to coordinate/verify (prior to bid) the requirements of the Authority Having Jurisdiction over this project and bring any discrepancies to the Engineer's attention at least seven (7) days prior to bid. No changes in contract cost will be acceptable, after the bid, for work and/or equipment required to comply with the Authority Having Jurisdiction.

C. The Contractor is advised that circuit routing for this system is not shown on the project drawings. The Contractor shall provide and install all raceways, wiring and cabling required for a complete and fully functional system as intended by these specifications. Contractor shall provide and install a properly sized, flush mounted outlet box for every device with appropriate raceway to accessible location above ceiling. Contractor shall size and route raceways to accommodate the proper installation of the system cabling. In locations where raceway and/or conduit is not accessible after completion of the project, and in non-ceiling areas, and in exposed locations, cabling shall be installed in appropriate raceway system complete to concealed/accessible location and/or termination equipment. Connect each device as required to perform requirement specified herein and/or on the drawings. Contractor shall properly terminate each device according to the manufacturer's recommendations.

1.3 DESCRIPTION OF SYSTEM

A. The Contractor shall furnish and install a complete Local Area Sound System(s). The system shall include but not be limited to:

1. Flush in-wall enclosure.
2. Inputs for 6 low impedance balanced microphones and 2 auxiliary sources.
3. Compression circuiting.
4. Output provisions of 25V or 70.7V constant voltage lines.
5. 9 band graphic equalizer.
6. Microphones, microphone stands and receptacles.
7. Surge suppression equipment on power source.
8. Priority muting.
9. Ability to select speakers in zones as called for on drawings so that any input may be heard over any one (1), two (2), three (3) or four (4) zones, individually or in any combination. Provide and install switches to perform this function.
10. Speakers, backboxes, etc.

11. Raceway/outlet system, wire, cable, etc., complete with all basic materials.
12. Wire and cable labeling.
13. Terminal blocks.
14. Terminations.
15. Grounding.
16. Surge suppression.

B. The system is to include all equipment, materials, and labor as required to provide, install and test a complete system as described herein.

C. System is to provide for distribution to local speakers all paging and/or emergency all-call signals originated from DTMF type telephone system, by microphone or integrated interface system.

D. System is to provide for distribution to local speakers all local microphone and/or input signals.

E. System speakers shall be tapped for individual room requirements. Speakers shall be tapped, main system amplifier sized, and overall system balanced to allow minor system adjustments after installation has been substantially completed. In no instance shall any speaker be tapped to its minimum setting prior to final adjustments.

F. Special Requirements for Cable Routing and Installation:

1. The majority of speaker wiring within buildings will be installed above ceilings. All cabling used throughout this project shall comply with the requirements as outlined in the National Electric Code (NEC). All cabling shall bear CMP and/or appropriate markings for the environment in which they are installed.
2. The Contractor shall be responsible for any damage to any surfaces or work disrupted as a result of his work. Repair of surfaces, including painting, shall be included as necessary.
3. Maintain proper separation between system cables and all power and/or unshielded cables, as required to prevent noise, crosstalk, etc.

G. Surge Suppression:

1. Provide and install all materials, labor and auxiliaries required to furnish and install complete surge suppression for the protection of building electronic equipment systems from the effects of induced transient voltage surge and lightning discharge as indicated on drawings or specified in this section.
2. See Specification Section Surge Protection Devices for surge suppression equipment required for 120 VAC and above circuits.

1.4 STANDARDS, CODES, REFERENCES, AND REGULATORY REQUIREMENTS

A. The equipment and installation shall comply with Division 1 and the current or applicable provisions of the following standards:

1. All requirements of EIA/TIA.
2. All requirements of Federal Communications Commission.
3. National Fire Protection Association Standards - NFPA 70 National Electric Code
4. UL 13 - Power-Limited Circuit Cables
5. UL 444 - Communications Cables
6. UL 1449, 3rd Edition Standard for Safety for Surge Protective Devices

7. Florida Administrative Code 6A-2/SREF (Schools)

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and show.

C. Surge Suppression

1. Equipment Certification: When available by any one manufacturer, all surge suppression equipment shall be listed by Underwriters' Laboratories, shall bear the UL seal and be marked in accordance with referenced standard. Such surge suppression equipment shall be UL listed and labeled for intended use.

2. Comply with all standards and guides as listed under "References" above.

1.5 RELATED SECTIONS/DIVISIONS/DOCUMENTS

A. All applicable sections of Division 0 and Division 1.

B. All applicable sections of Divisions 26, 27 including, but not limited to,:

1. Section Surge Protection Devices

1.6 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum ten (10) years experience and with service facilities within 50 miles of Project.

B. Supplier: Authorized distributor of amplifier/control equipment manufacturer.

C. Installer:

1. Company specializing in installing the products specified in this section with minimum ten (10) years experience.

2. The installing Contractor shall be a direct sales division of, or the authorized and designated distributor for the amplifier system manufacturer.

3. Installing Contractor shall maintain a local staff of specialists, including a Superintendent, for planning, installation, and service.

4. The installing Contractor shall maintain an office within fifty (50) miles of the project with capability to provide emergency service. The installing Contractor shall have been actively engaged in the business of selling, installing and servicing educational intercommunication systems for at least ten (10) consecutive years going back from date of bid.

D. Surge Suppression

1. All surge suppression devices shall be manufactured by a company normally engaged in the design, development, and manufacture of such devices for electronics/communications systems equipment.

2. The surge suppressor manufacturer shall offer technical assistance through support by a factory representative and local stocking distributor.

3. Coordination/Project Conditions

a) Verify proper grounding is in place.

b) Verify proper clearances, space, etc. is available for surge suppressor.

E. To establish the type and operating characteristics of the Local Area Sound System(s), the equipment specified herein is used as a guide in determining the functions of the system. Other equipment will be considered for acceptance provided the following is submitted in writing by the system installer to the Engineer.

1. Contractor qualifications (as listed above).
2. Complete lists, descriptions and drawings of materials to be used.
3. A complete drawing showing conduit, conduit sizes, backboxes, number of wires and wire sizes.
4. A complete riser diagram of the Local Area Sound System(s).

1.7 SUBMITTALS

A. Submit in accordance with Section Common Work Results and Division 1 requirements.

B. In addition to requirements above, the Contractor shall submit:

1. Narrative of operation of System as provided. (Submittal will not be reviewed by the A/E without this narrative.)
2. Manufacturer's data on all products, including but not limited to:
   a) Catalog cut sheets.
   b) Roughing-in diagrams.
   c) Installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
   d) Operation and maintenance manuals.
   e) Typical wiring diagrams and risers.
   f) The Contractor shall submit test reports, manufacturers' specifications and any other information necessary to determine compliance with material and equipment specifications described herein.
   g) Complete wiring diagram for speaker zone switching and School Intercom System With Time Program Clock Modular Administrative Communications System interface.
3. Included as part of the shop drawing submittals shall be an overall plan of the site indicating the following:
   a) All speaker locations
   b) The transformer tap value for each speaker
4. Manufacturer's drawings showing all dimensions (height, width, and depth) for all cabinets used to house system components. Provide catalog pages, mounting details and specification sheets for all system components and rough-in boxes.
5. Indicate layout of equipment mounted in racks and cabinets, component interconnecting wiring, and wiring diagrams of field wiring to speakers and remote input devices (where applicable).
6. Surge Suppression
   a) Surge protective data for 120 volt power source.
   b) Submit Product Data for each type of suppressor:
      1. Dimensions.
      2. Means of mounting.
      3. Compliance with U.L Standards referenced.

4. Compliance with IEEE Standards referenced.
5. Design type (Hybrid, MOV).
6. Size of wire leads.
7. Warrantee.
8. Performance data showing compliance with performance as specified herein.
9. Complete schematic data on each suppressor type indicating component values, part number, conductor sizes, etc.
10. Manufacturer's certified test data on each suppressor type.
11. Test data from an independent test laboratory.

7. Name, qualifications, etc. of company providing and installing system.
8. Qualifications of installer. Submit proof installer meets specified requirements.
9. Proof of UL Listing. Indicate the UL listing, the UL classification, and NEC insulation type used for each type of wire to be used in installation of system.
10. Submit manufacturer's qualification certificates for all employees accomplishing the work of this project.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Article REGULATORY REQUIREMENTS.

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

E. Submit test reports, manufacturer's specification sheets and any other information necessary to determine compliance with material and equipment specifications described herein.

1.8 PROJECT RECORD DOCUMENTS

A. Submit in accordance with Section Common Work Results and Section Operation and Maintenance Manuals.

B. In addition to the requirements above, the Contractor shall submit:

1. Record actual locations and sizes of pathways, speakers, terminal blocks, etc.
2. Record actual type and size of cables installed.
3. Record "to and from" locations coordinated with cable labeling for all cables at each terminal block or cabinet.
4. Final tap value for each speaker location.
5. Provide detailed documentation of the distribution system to facilitate system administration, system maintenance and future system changes. This requirement includes as-built drawings, detailed cable drawings, with all cables and terminations identified, a bill of materials of all installed equipment and wiring, rack and backboard equipment layouts showing placement of support equipment, and model and serial numbers of all installed equipment (cables, connectors, outlets, equipment). A clear and consistent nomenclature scheme is to be defined and used on the documentation and the cable labeling which facilitates locating and identifying each cable.
6. Cable Route Diagram: Provide locations and routes of "as-built" cable system and include:
   a) End points.
   b) Cable routing.

c) Splice points.

d) Terminations (connector type).

e) Cable lengths (include slack).

7. Drawings required herein are in addition to those required under "OPERATION AND MAINTENANCE DATA".

1.9 OPERATION AND MAINTENANCE DATA

A. Submit in accordance with Section Common Work Results and Section Operation and Maintenance Manuals.

B. In addition to the requirements above, the Contractor's O & M Manuals shall include:

1. A complete as-installed equipment list, listed by room, with manufacturers' names, model numbers, serial numbers, and quantities of each item.

2. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers and layouts, and other designations and codings (point-to-point wiring diagrams). System performance measurements shall be documented as noted elsewhere in this specification.

3. Riser diagrams showing as-installed conduit with pull boxes, outlet boxes, physical cable layouts, part numbers of cable types used, and number of circuits in each conduit.

4. Operation Data: Include instructions for adjusting, operating, and extending the system.

5. Maintenance Data: Include repair procedures and spare parts documentation for each and every major equipment item furnished.

6. Test Data: Record of results for all cables/cable runs tested.

7. Data sheets showing all field labeling used for termination blocks, cable runs, speakers and on equipment.

8. Service manuals for each and every major equipment item furnished.

9. Manufacturer's warranties and operating instructions for each and every equipment item furnished. Include a copy of the certificate of warranty, signed by both parties.

10. Technical Systems Operations Manual, custom-written by the Contractor, for the purpose of instructing the Owner's operating personnel in the detailed step-by-step operation of the system and preventive maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.

11. Surge Suppression

a) O & M data to include:

1. All accepted shop drawings, product data, and/or cutsheets.

2. Installation, connection, and maintenance information on each type of surge suppression.

3. Procedure and/or time table for recommended periodic inspection of devices to determine continued usefulness.

12. Complete equipment rack layouts showing locations of all rack mounted equipment items.

C. Drawings required herein are in addition to those required under "PROJECT RECORD DOCUMENTS".

1.10 WARRANTY

A. The Contractor shall warrant the equipment to be new and free from defects in material and workmanship, and will, within one year from date of acceptance by owner, repair or replace any equipment found to be defective.

1. No charges shall be made by the installer for any labor, equipment, or transportation during this period to maintain functions.

2. Respond to trouble call within twenty-four (24) hours after receipt of such a call.

B. The Contractor shall guarantee all wiring and raceways to be free from inherent mechanical or electrical defects for one (1) year from date of final acceptance of the system.

C. Surge Suppression

1. All surge suppression devices shall be warranted to be free from defects in materials and workmanship for a period of five (5) years.

2. Any suppressor which shows evidence of failure or incorrect operation during the warranty period shall be repaired or replaced by the manufacturer and installer at no cost to the owner.

1.11 MAINTENANCE SERVICE

A. Furnish service and maintenance of Local Area Sound System(s) for one (1) year from date of Substantial Completion.

1. No charge shall be made by the installer and/or Contractor for any labor, equipment, or transportation during this period to maintain functions.

2. Respond to trouble call within twenty-four (24) hours after receipt of such call.

1.12 OWNER'S INSTRUCTION:

A. Training of school personnel and facilities services personnel (a minimum of two) shall be provided.

B. Training to cover the operation, location, nomenclature, documentation, documentation maintenance procedures, a "walk-through" for location and labeling orientation, operation of equipment installed as part of the contract, test documentation, and troubleshooting of the system.

C. Provide instruction to the Owner's designated personnel upon completion of the system installation. Videotape all training sessions and deliver (4) copies of tapes to Owner (for use in future training).

PART 2 - PRODUCTS

2.1 GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS

A. All equipment shall be new and unused. All components and systems shall be designed for uninterrupted duty. All equipment, materials, accessories, devices, and other facilities covered by this specification or noted on the contract drawings shall be the best suited for the intended use and shall be provided by a single manufacturer.

B. Provide all components, equipment, parts, accessories and associated quantities required for complete installations. All components may not be specified herein.

C. All devices/components/products shall be suitable for use intended, and meet all stated performance requirements for Local Area Sound System(s) specified in this section.

D. Manufacturers:

1. Basis of Design:

a) Crown .

2. Acceptable Substitution

a) QSC

b) Other manufacturers as approved by Orange County Electrical Engineer.

2.2 RACEWAYS

A. General:

1. All raceways (conduit, wireways, pullboxes, outlet boxes, etc.) shall comply with applicable requirements of sections within Division 26, Division 27 of these specifications.

B. Conduit: Comply with Section Conduit except as noted below:

1. Pull Cords: Install pull cords in all raceway runs that are installed without cable.

2. Size: Minimum size shall be 3/4" conduit.

C. Bridle Rings

1. Provide size as required for cables, with a maximum fill of 50% cross-area.

2. Provide mounting/fastener type as required for installation.

3. Manufacturers: Caddy Series #2B/4B or acceptable substitution.

D. Boxes:

1. All outlet boxes, junction boxes, pull boxes, etc. shall comply with applicable section of these specifications.

2. Boxes shall be sized as required by the system manufacturer and NEC for cables and/or device installed.

2.3 EQUIPMENT CABINET

A. All silicon, solid state, professional quality, amplifier capable of delivering the necessary power tp deliver clear and adequate power at less than 2% harmonic distortion from 33 Hz. to 19 kHz.

B. Frequency Response:

1. +/- 2dB from 13 Hz to 19kHz and output regulation within 2dB from no load to full-rated load.

2. Sensitivity of amplifier shall be such that it will produce full output with a 0.3 mV input from a low-impedance microphone 0.15 volt from a signal fed into auxiliary input.

C. Provide input facilities for six low impedance balanced microphones.

1. Two inputs shall also be provided for high impedance high-level sources such as AM FM tuner, crystal or ceramic phone cartridges, tape recorder or other auxiliary sound source.

D. It shall be possible to control the gain of and mix each of the six microphones and two auxiliary input channels separately with linear-action level controls.

1. Separate bass and treble controls shall provide up to 8dB boost and 12 dB attenuation.

2. A linear action master volume control shall set the overall gain.

E. Amplifier shall provide floating (balanced) or one-side grounded output for impedance of 8 and 16 ohms.

1. Provide constant voltage outputs of 70 volts and 25 volts.

2. Remote precedence and gain control shall be possible, using accessory adapters.

F. Locate all controls on a recessed panel and provide a hinged locking cover to cover all controls.

1. Recessed panel shall also have jacks for tape input and output.

2. Locate a low impedance 3 pin microphone receptacle on front panel and accessible with locking cover closed.

3. Amplifier shall have screw terminal connection facilities for all input channels and for all output connections.

G. AC receptacle for supply of power to associated equipment shall be available on front panel.

H. Unit shall be rugged and temperature-stable and operate between ambient temperatures of 20°C (4° F) and + 55° (+ 130° F).

I. Protect amplifier with a front panel-mounted, push-button circuit breaker and internal thermostat and designed to operate from a 50-60Hz source at 105-125 volts ac or a 48 volt dc supply.

J. Enclosure shall be flush mounted with provisions for entry of power cable or conduit and for all input and output lines.

1. Front panel shall have a hinged access door provided with a tamper proof lock.

2.4 SPEAKER ASSEMBLIES

A. Speaker: (8) JBL Pro Model Control 31, dual driver, dual input high power weatherproof loudspeaker with 250 watts RMS, 1000 peak for 2 hours minimum..

2.5 FLOOR/GROUND MICROPHONE OUTLETS

A. Microphone receptacle floor box and cover:

1. Floor box shall be as shown on drawings complying with applicable section of these specifications.

2. Lid and Cover: Solid cast commercial brass with a satin finish and coated with a clear lacquer.

3. Lid shall require no tools for opening and shall be flush with the floor when closed.

4. Microphone receptacle floor box and cover shall have an adapter punched for a C3F microphone connector.

5. Provide gangs as required for devices shown on drawings.

2.6 WALL MICROPHONE OUTLETS

A. Soundolier 5601-136 consisting of a Switchcraft B3F connector mount on a stainless steel plate.

2.7 MICROPHONES

A. Shure Model 54550-CN or accepted substitution, cardioid pattern microphone (two required).

1. Each microphone shall have internal double shock mounting to isolate against mechanical and handling noises.

2. Response shall be 50 to 15,000 Hz and output level at 1kHz shall be 56 dB referencing 1MW/10 microbars.

3. Provide all necessary connectors.

2.8 MICROPHONE STANDS

A. Atlas Model MS-12C floor type microphone stands, or accepted substitution (two required).

2.9 SPEAKER ZONE SELECTIVE SWITCH PANEL

A. Switches to be as called for on detail on drawing.

B. Switches to be mounted on engraved stainless steel plate.

C. Flush mounted.

2.10 INTERFACE CABINET

A. NEMA 4X enclosure to comply with requirements in applicable section of these specifications.

B. Flush or surface mounted as shown on drawings.

C. Complete with all terminal strips, relays, etc. as called for on detail on drawing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Install equipment in accordance with manufacturer's instructions.
2. Install all equipment in appropriate enclosures.
3. Install equipment, cables, and speakers as required to comply with all applicable requirements of the references and/or regulatory requirements called for under PART 1 of this section of specifications, as a minimum installation requirement. Exceed this minimum requirement when called for herein.
4. Install all electrical basic materials per applicable sections of these specifications.
5. Connect reproducers to amplifier with matching transformers.
6. Install system cabinets/racks in locations shown; arrange to provide adequate ventilation and access.
7. Properly ground system per applicable sections of these specifications.
8. Support raceways and cabinets under the provisions of Section Hangers and Supports, and/or as required by manufacturer's instructions.
9. Install raceways to conform to applicable sections of these specifications.
10. Install system wiring and/or raceways away from any surface that may become hot, including and not limited to, hot water piping and heating ducts.
11. Install system wiring with at least 12 inches of separation from line voltage power wiring on parallel runs. Wiring crossing power circuits shall be at right angles. For metal enclosed electric light or power or Class 1 circuits, separation may be reduced as described in NEC latest edition. Increase separation if so required to comply with EIA/TIA referenced standards.
12. Special Requirements for Cable Routing and Installation:

a) The majority of speaker wiring within buildings will be installed above ceilings. All cabling used throughout this project shall comply with the requirements outlined in the National Electric Code (NEC). All cabling shall bear CMP and/or appropriate markings for the environment in which they are installed.

b) The Contractor shall be responsible for any damage to any surfaces or work disrupted as a result of his work. Repair of surfaces, including painting, shall be included as necessary.

c) Maintain proper separation between system cables and all power and/or unshielded cables, as required to prevent noise, crosstalk, etc.

13. Install all equipment at locations shown on drawings.

14. Connect all devices, outlets, speakers, etc. to equipment cabinet equipment as recommended by manufacturer(s).

B. Pathway

1. General

a) Provide and install raceway for all penetrations of fire rating assemblies/walls/etc., where exposed to damage, underground locations, interconnection of cabinets or any combination thereof, for all cables, and all areas required by applicable codes and standards or as otherwise noted/required in these specifications.

b) Where acceptable to Authority Having Jurisdiction and all applicable codes/standards, cables above accessible ceilings may be run without raceways provided complete installation complies with all applicable codes/standards. Proper cable type, sleeves and support hardware must be utilized.

c) All raceways shall meet requirement for raceway per Section Data Communications Integration Requirements in addition to applicable requirement of sections within Division 26 and Division 27 of these Specifications.

d) All raceways shall terminate at point within 12 inches of termination point terminal block with appropriate grounding bushing.

e) Raceway shall not be shared by power or any other electrical wiring that is not part of the low voltage sound systems.

f) Bend raceway with minimum inside radius of 6 times the internal diameter. Increase bend radius to 10 times for raceway larger than 2 inch size. Provide proper bend for all changes of direction. Pull and splice boxes shall not be used in lieu of a bend.

g) Install raceways so no more than two 90^{o} bends are in any raceway section without pullbox. Install additional pullboxes as required to maintain maximum of two 90^{o} bends between pullboxes and/or termination points.

h) Label all raceway at both ends to indicate destination and sound system source room. Also indicate length of raceway and this labeling/identification shall be fully documented in as-built (record) drawings.

i) Install polyethylene pulling string in each empty conduit over 10 feet in length or containing a bend.

j) Properly support cables/wire not installed in raceways.

k) Special Raceway Systems: Special raceway systems may be specified for some portions of the sound system. Refer to the drawings and other sections of these specifications to determine where or if such systems are used.

2. Horizontal Cable Pathway

a) Sleeves

1. Install rigid steel conduit sleeves with bushings on both ends at penetration of all walls above ceilings. Stub-out each side of wall a minimum of 12 inches.

2. Size sleeves as required by the NEC for cable installed, but in no case shall sleeve be less than 2 inch diameter, nor smaller than that required by "4)"

below.

3. Sleeve size shall not be smaller than that required by EIA/TIA-569, Table 4.1-1, "Conduit Sizing."

b) Cable Support

1. Install J hooks located 48 inches to 60 inches on center above accessible ceiling areas for cable support.
2. Where large quantity of cables are congested in an area such as near CC or CER, provide/install special supports designed to carry weight.
3. Size shall be as required to provide for cables installed plus 50% spare and still not exceed rating of support device.
4. Tie all cables to J hooks at all bends with ties accepted for use.

3. Pullboxes, Splice (Junction) Boxes, Outlet Boxes

a) Install per applicable sections of these specifications and all applicable codes/standards.

b) Boxes shall be placed above accessible ceilings and in an exposed manner and location, and readily accessible. Boxes shall not be placed in a fixed false ceiling space unless immediately above a suitably marked and rated hinged access panel.

c) A pull or splice box shall be placed in a conduit run where:

1. the length is over 100 feet,
2. there are more than two 90^{o} bends, or
3. if there is a reverse bend in the run.

d) Boxes shall be placed in a straight section of conduit and not used in lieu of a bend. The corresponding conduit ends should be aligned with each other. Conduit fittings shall not be used in place of pull boxes.

e) Outlet boxes shall be installed at speakers requiring outlet box per applicable codes/standards.

f) Provide bushed nipple at speakers receiving cable without raceway/conduit.

g) Every pullbox and/or splicebox shall have a hinged cover. Install appropriate access panel to allow cover to open.

h) Size

1. Where a pullbox is required with raceway(s) smaller than 1-1/4 trade size, an outlet box may be used as a pullbox.
2. Where a pullbox is used with raceway(s) of 1-1/4 trade size or larger, the pull box shall:

(a) for straight pull through, have a length of at least 8 times the trade size diameter of the largest raceway;

(b) for angle and U pulls:

(1) have a distance between each raceway entry inside the box and the opposite wall of the box of at least 6 times the trade size diameter of the largest raceway, this distance being increased by the sum of the trade size diameters of the other raceways on the same wall of the box; and

(2) have a distance between the nearest edges of each raceway entry enclosing the same conductor of at least:

(i) ·six times the trade size diameter of the raceway; or

(ii) ·six times the trade size diameter of the larger raceway if they are of different sizes.

(c) for a raceway entering the wall of a pullbox opposite to a removable cover, have a distance from the wall to the cover of not less than the trade size diameter of the largest raceway plus 6 times the diameter of the largest conductor.

3. Where a splicebox is used with raceway, it shall be sized per EIA/TIA latest edition, "Splice Box Sizing."

4. No box shall be smaller than that required by NEC 314.28 (A), (1) and (2).

C. Grounding

1. Provide and install complete grounding system as required to comply with all sections of these specifications and applicable codes.

2. Connect Central Equipment to "systems" ground bus with #6 green insulated copper ground wire (in appropriate raceway).

3. Connect metal conduit (via grounding bushing) to equipment cabinet or cabinet ground bus.

4. Connect cable shields to equipment cabinet ground busbar.

5. Connect surge suppression equipment to equipment cabinet ground busbar.

D. Speakers

1. Mount ceiling speakers in or on ceiling system at locations shown on drawings as directed by ceiling system Contractor, manufacturer, and installer. Provide all required mounting hardware and/or accessories. In general, all speakers shall be recessed mounted in the ceiling system. Where speaker cannot be recessed, install surface speaker assembly.

a) Speakers mounted in acoustical tile ceilings shall have support bridge.

2. Connect speakers together so that no speaker circuit exceeds either five speakers or 3.5 watt load.

3. Each speaker circuit shall have a separate, splice-free cable homerun to the termination block in the sound system equipment cabinet (or local area School Intercom System With Time Program Clock Modular Administrative Communications System interface cabinet, when required).

E. Surge Suppression

1. General

a) Provide and install surge suppression devices as specified in Section Surge Protection Devices for 120 volt source to all equipment. Install on line side of equipment.

b) Extreme care shall be taken by Contractor to assure a properly surge protected system.

c) Surge protection equipment must be selected by Contractor to match the equipment being protected including wire sizes, operating volts, amps, and circuit

impedance.

d) Installation of surge protection equipment and it's grounding must be per manufacturer's recommendations to assure short and proper ground paths.

2. Equipment Selection

a) Contractor to coordinate with suppliers and installers of all equipment being protected and provide surge suppression equipment which meets these specifications on respective equipment, wires, etc.

3. Equipment Installation

a) Install surge suppression equipment per manufacturer's recommendation at each wire terminal as noted under Part 1.

b) Install in surge suppression equipment terminal cabinets, etc. as required to facilitate installation of surge protection equipment and terminal points. Increase size of terminal cabinets (from that shown on drawings) to size required to facilitate installation of surge suppression equipment and terminal blocks.

c) Locate surge suppression equipment in terminal cabinet nearest main equipment cabinet.

4. Ground Installation

a) Ground Bus Connections:

1. Provide "local" ground bus in equipment cabinet housing surge protection equipment (with lugs, etc. as required).

2. Bond "local" ground bus to equipment cabinet with minimum #6 copper wire.

3. Connect terminal cabinet "local" ground bus to "systems" ground bus installed per Section Grounding and Bonding with minimum #6 copper insulated wire (unless otherwise noted) in conduit.

4. Note that "systems" ground bar is also to be used for power transformation ground (480V to 208V) where applicable.

b) Surge Suppression Equipment Grounding:

1. Connect each surge suppressor to local ground bus in terminal cabinet with wire sized as recommended by manufacturer.

c) Conductors:

1. Conductors shall meet requirements of Section Building Wire and Cable.

2. Bends in excess of 90 degrees in any grounding conductor shall not be permitted. A radius of 6 inches or greater shall be maintained on all bends.

3. Do not bundle unprotected conductors with protected conductors.

4. Conductors shall be kept as short as possible.

5. Conductors shall be secured at 12" intervals with an accepted copper clamp.

6. Grounding conductors shall be properly connected to the building service ground by accepted clamps.

d) Grounding Connectors:

1. Connectors, splicers, and other fittings used to interconnect grounding conductors, bond to equipment or grounding bars, shall be accepted by NEC or UL for the purpose.

2. All connectors and fittings shall be of the Nicopress crimp or compression set screw type.
3. Special treatment to fittings, lugs, or other connectors of dissimilar material shall be applied to prevent electro-galvanic action.

F. Cable/Wire:

1. Splice cable only at terminal block units.
2. Make cable shields continuous at splices and connect speaker circuit shield to equipment ground only at building surge protection devices and at amplifier and/or as otherwise required by applicable codes.
3. Install input circuits in separate cables and raceways/pathways from output circuits.
4. Install all cables no closer than 12" from any wire/cable installed for Premise Distribution System, power system cable/raceway, or fluorescent/ballasted light fixtures.
5. Leave 12 inches excess cable at each termination at speaker and termination blocks.
6. Leave 2 feet excess cable at each termination at system equipment/rack.
7. Provide protection for exposed cables where subject to damage.
8. Support cables above accessible ceilings to keep them from resting on ceiling tiles. Use J hooks to support cables. Do not share J hooks of Premise Distribution System. Provide quantity of J hooks as required to provide 50% spare capacity at all J hooks.
9. Use suitable cable fittings and connectors.
10. Install appropriate cable to match application, i.e., plenum, riser, etc. All cables shall bear CMP and/or appropriate marking for the application in which they are installed.
11. Label cable at both ends indicating the originating and terminating location of each end. This labeling/identification shall be fully documented in as-built (record) drawings.

G. Speaker Zone Selective Switch Panel:

1. Install flush in wall adjacent to sound system equipment rack.
2. Engraved stainless steel plate to label zone number (1, 2, 3,..) for each switch. Label plate "SPEAKER ZONES".
3. Connect into amplifier output and local sound system/School Intercom System With Time Program Clock Modular Administrative Communications System interface cabinet. Connections/schematic diagrams on drawings/details are schematic only and are not intended to be complete nor point-to-point wiring diagrams. Connect system(s) as required to provide performance specified herein. Switches are to provide selection of speaker zones (1, 2, 3, and/or 4) so that any zone or zones may be selected by user for distribution of program material (microphone input or auxiliary input device).

H. Local Sound System/School Intercom System With Time Program Clock Modular Administrative Communications System Interface Cabinet:

1. Install flush or surface mounted as called for on drawings.
2. Install and connect all devices to provide functions/performance specified herein.
3. Connect into amplifier output (and/or speaker zone selection switch panel output) and connections/schematic distribution speakers. Diagrams on drawings/details are schematic only and are not intended to be complete nor point-to-point wiring diagrams. Connect system(s) as required to provide performance specified herein. System shall automatically switch distribution speakers from sound system amplifier output circuit(s)

to School Intercom System With Time Program Clock Modular Administrative Communications System output upon any emergency or all call announcement from any telephone system instruments.

I. Circuit sound system speakers in groups and zones as required to properly interface speakers with both the School Intercom System With Time Program Clock Modular Administrative Communications System, the sound system, and the zone selection switches.

3.2 MANUFACTURER'S FIELD SERVICES

A. Provide manufacturer's field services.

B. Include making or supervising final wiring connections, inspection and adjusting of completed installation and systems demonstration.

C. Certify that installation is complete and performs according to specified requirements.

3.3 FIELD QUALITY CONTROL

A. Test per applicable sections of these specifications.

B. Measure and record sound power level.

3.4 ADJUSTING

A. Adjust transformer taps for appropriate sound level.

3.5 DEMONSTRATION

A. Demonstrate system to designated Owner personnel as required by applicable sections of these specifications.

B. Conduct walking tour of project. Briefly describe function, operation, and maintenance of each component.

C. Provide detailed operation and maintenance instruction and training.

D. Use submitted operation and maintenance manual as reference during demonstration and training.

END SECTION

Division 28

Electronic Safety and Security

SECTION 28 16 00 - INTRUSION DETECTION SYSTEM (PRE-WIRE) (Reference Only)

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. Provide a complete Intrusion Detection System for the Owner's security use comprised of Contractor provide and Install materials (as noted below) and Owner's Vendor provided and installed materials (as noted below) for a complete and fully functional systems.

B. Intrusion Detection Systems Panels shall sit on the Owner's network. No backbone cabling is required.

C. Doors with Access Control System Card Readers are to be provided with a DPDT door contacts to allow one set of contacts to be used for Intrusion Detection System and one set of contacts to be used for the Access Control System.

1.3 REFERENCES

A. NFPA 70 National Electrical Code (NEC)

B. NFPA 731, Chapter 5 Standard for the Installation of Electronic Premises Security Systems

1.4 SYSTEM DESCRIPTION

A. Provide a pre-wire complete and ready for the Owner’s preferred contractor. Owner will directly contract the vendor for the Intrusion Detection System. The Contractor Shall provide the infrastructure.

1.5 SUBMITTALS

A. Shop Drawings: Indicate system wiring diagram showing each device and wiring connection required.

B. Product Data: Provide electrical characteristics and connection requirements.

C. Test Reports: Indicate satisfactory completion of required tests and inspections.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.6 PROJECT RECORD DOCUMENTS

A. Submit record documents to record actual locations of device rough-ins and cable routing.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years experience, and with service facilities within 50 miles of Project.

1.8 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by UL as suitable for purpose specified and indicated.

PART 2 - PRODUCTS

2.1 ALARM CONTROL PANEL

A. Provided by the Owner.

B. Rough-in and pre-wiring by Contractor.

C. Surge protection: Provide on power supply and all circuits entering/leaving building housing main control panel.

D. Manufacturer:

1. Sonitrol

2.2 INITIATING DEVICES

A. Provided by Owner.

B. Rough-in and pre-wiring by Contractor.

2.3 KEYPADS

A. Provided by Owner.

B. Rough-in and pre-wiring by Contractor.

2.4 WIRING

A. The proper cable and wiring as recommended by the system manufacturer shall be provided for connecting all devices in system:

1. Door contacts shall be wired from the contact to the control panel. The cable shall be 22AWG 2 conductor, with ten (10) feet slack at each end. Basis of design is Belden #6500UE.

2. Key pads shall be wired from the device to the control panel. The cables shall be Cat 6 and 16/2 AWG conductors with ten (10) feet slack at each end. Basis of design is per Specification Section 27 26 26 for Cat 6 and Belden #5200UE.

3. Data wiring between Control Panel and Systems Terminal Cabinets shall be 22AWG4 conductor, with twenty (20) feet slack at each end. Basis of design is Belden #6541PA or Belden #82723.

2.5 PATHWAYS

A. General:

1. All pathways (conduit, raceways, wireways, pullboxes, outlet boxes, etc.) shall comply with applicable requirements of sections within Division 26, Division 27 of these specifications.

2. All pathways (conduit, raceways, wireways, pull boxes, outlet boxes, etc.) shall comply with all requirements of EIA/TIA-569.

B. Conduit. (Comply with Section Conduit except as noted below):

1. Bushings: Provide insulated bushings on ends of all raceway. All backbone conduits shall have bonding bushings and be bonded to the Systems Ground Bus Bar with an insulated #6 AWG wire.

2. Pull Cords: Install pull cords in all raceway runs that are installed without cable.

3. Size:

a) See Part 3 for size requirements.

b) Minimum size shall be 1 inch.

C. J-hooks:

1. Provide size as required for cables, with a maximum fill of 50% cross-area.

2. Provide mounting/fastener type as required for installation.

3. Manufacturers: Basis of design - Caddy Series CAT 12/CAT 21/CAT 32.
4. Accepted Substitution: B-Line Series BCH 64/BCH 32/BCH 21.

D. Boxes:

1. All outlet boxes, junction boxes, pull boxes, etc. shall comply with applicable section of these specifications.
2. Boxes shall be sized as required by EIA/TIA and NEC for cables, conduit and/or device installed.
3. Junction/pull boxes shall not be mounted more than ten (10) feet above the floor and must be mounted in such a way as to make them readily accessible.
4. Junction/pull boxes shall not be placed in a fixed false ceiling space unless immediately above a suitably fire rated, marked, hinged panel.

2.6 SURGE SUPPRESSION EQUIPMENT

A. Telephone Lines:

1. Must be UL 497 listed and labeled for primary protection.
2. Multi-stage hybrid protection circuit.
3. Plug-in replaceable modular design or individually mounted units.
4. Fail short/fail safe.
5. Surge Capacity: 500 amp with 10 x 700µs waveform.
6. Clamp Voltage: 150% of circuit peak operating voltage with 100 amp 10 x 700µs waveform.
7. Maximum continuous operating voltage: 125% of peak operating voltage, minimum.

B. Manufacturer: Atlantic Scientific DLM Series.

1. Approved substitution: Edco #COHP(FS).

C. Data Circuits

1. Must be UL 497B listed and labeled.
2. Multi-stage hybrid protection circuit.
3. Plug-in replaceable modular design or individually mounted units.
4. Fail short/fail safe.
5. Surge Capacity: 500 amp with 10 x 700µs waveform.
6. Clamp Voltage: 150% of circuit peak operating voltage with 100 amp 10 x 700µs waveform.
7. Maximum continuous operating voltage: 125% of peak operating voltage, minimum.
8. Manufacturer: Atlantic Scientific DLM Series.
9. Approved Substitution: Edco #PC642C Series, SSF Series, SRS Series, LCHP Series, COHP Series.

2.7 FIRE DEPARTMENT KEY LOCK

A. Refer to Specification Section Building Accessories.

PART 3- EXECUTION

3.1 INSTALLATION

A. General

1. Install equipment in accordance with manufacturer's instructions.
2. Install equipment, cables, raceways and outlets as required to comply with all applicable requirements of the references and/or regulatory requirements called for under Part 1 of this section of specifications, as a minimum installation requirement. Exceed this minimum requirement when called for herein.
3. Install all electrical basic materials per applicable sections of these specifications.
4. Install system cabinets/racks in locations shown; arrange to provide adequate ventilation and access.
5. Coordinate location of equipment with drawings.
6. Properly ground system per applicable sections of these specifications.
7. Support raceways, backboards, and cabinets under the provisions of Section Hangers and Supports, and/or as required by manufacturer's instructions.
8. Install raceways to conform to applicable sections of these specifications.
9. Install Intrusion Detection System wiring and/or raceways away from any surface that may become hot, including and not limited to, hot water piping and heating ducts.
10. Install Intrusion Detection System wiring with at least 12 inches of separation from line voltage power wiring on parallel runs. Wiring crossing power circuits shall be at right angles. For metal enclosed electric light or power or Class 1 circuits, separation may be reduced as described in NEC. Increase separation if so required to comply with EIA/TIA referenced standards.
11. Special Requirements for Cable Routing and Installation:
    a) The majority of the Intrusion Detection System wiring within buildings will be installed above ceilings. All cabling used throughout this project shall comply with the requirements outlined in the NEC. All cabling shall bear CMP and/or appropriate markings for the environment in which they are installed.
    b) The Intrusion Detection System Contractor shall be responsible for any damage to any surfaces or work disrupted as a result of his work. Repair of surfaces, including painting, shall be included as necessary.
    c) Maintain proper separation between Intrusion Detection System cables and all power and/or unshielded cables, as required to prevent noise, crosstalk, etc.
12. Each Intrusion Detection System outlet shall have splice-free cables homerun to the respective control panel in the associated Main/Intermediate Distribution Frame (MDF/IDF) at the communication equipment room (CER), communication closet (CC), or communication panel (CP) as indicated on the drawings. Each cable shall be tagged at each end.

B. Install recessed magnetic switch outlet boxes on new doors indicated on plans.

C. Install key pad outlet boxes at locations indicated on drawings.

D. Install terminal cabinets as indicated on plans in CER, or Systems Room.

E. Installation of devices and terminations will be done by Owner's Vendor.

3.2 FIELD QUALITY CONTROL

A. Field inspection and testing to be performed.

B. Test in accordance with NFPA 731.

END OF SECTION

SECTION 28 31 00 – ADDRESSABLE FIRE ALARM-DETECTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The work described herein and on the drawings consists of all labor, materials, equipment, and services necessary and required to provide and test an automatic fire detection and alarm system. Any material not specifically mentioned in this specification or not shown on the drawings but required for proper performance and operation shall be provided.

B. Drawings and specifications comply to the best of the Engineer's knowledge with all applicable codes at the time of design. However, it is this Contractor's responsibility to coordinate/verify (prior to bid) the requirements of the Authority Having Jurisdiction over this project and bring any discrepancies to the Engineer's attention at least seven days prior to bid. No changes in contract cost will be acceptable, after the bid, for work and/or equipment required to comply with the Authority Having Jurisdiction.

C. Contractor is advised that circuit routing for this system is not necessarily shown on the project drawings. Contractor shall provide and install all raceways, wiring and cabling required for a complete and fully functional system as intended by these specifications. All wiring and/or cabling concealed within walls or in exposed locations shall be in conduit. Cabling located above lay-in ceilings may be run without conduit provided it is supported on J-hooks dedicated to fire alarm wiring. J-hooks shall be provided at a spacing of 5 feet or less. Contractor shall provide and install a properly sized, flush mounted outlet box for every device. Contractor shall size and route raceways to accommodate the proper installation of the system cabling. T-Tapped cabling shall not be acceptable. In locations where cabling is not accessible after completion of the project, conduit shall be provided. Contractor shall properly terminate each device according to the manufacturer’s recommendations. Provide and install firestopping where penetrations are made through rated walls and floors. Firestopping is to be performed under Division 7 Section Firestopping.

D. This Specification describes a fully addressable, common fire alarm system, with remote power supplies for various buildings and portables.

E. Contractor shall provide and install the fire alarm system (including all equipment, wiring, etc.) in accordance with the manufacturer’s recommendations.

1. Installation of devices shall be in accordance with the manufacturer’s requirements as well as the requirements of the Contract Documents. Recommendations by the Manufacturer for the proper installation of the fire alarm system and its equipment shall not preclude the requirement for the Contractor to comply with the requirements of the Contract Documents.

2. Termination of fire alarm circuits shall be in accordance with the manufacturer’s recommendations, applicable requirements of the National Electrical Code (NFPA 70), National Fire Alarm Code (NFPA 72), ADA, other applicable Codes and the Contract Documents.

3. Voice evacuation audio circuits (25 or 70V) shall be run separate from fire alarm data loops and other system circuits where the potential exists for interference or adverse effect upon the proper operation of the any fire alarm equipment, circuit or the system as a whole.

4. Fire alarm Installer shall be responsible for ensuring that prior to bidding the project the Electrical Contractor understands the raceway requirements for the project. Claims by the Contractor after award of the project in regard to additional raceway required either by the

fire alarm system manufacturer’s recommendations for proper installation of the system and its associated equipment, or for compliance with the requirements of the Contract Documents, shall not be allowed.

5. Contractor shall note that the drawings show fire alarm remote panels (FARP) in various locations. FARP's are intended to be equipment (remote control panels, power supplies, addressable modules, power, grounding, and any other equipment or materials) necessary for a remote extension of the fire alarm system. FARP's shall be connected to the campus FACP via a signal line circuit (SLC) and other circuits specifically recommended by the fire alarm manufacturer and required to meet the intent of the project documents. An individual FARP shall provide the necessary circuitry (notification appliance circuits (NAC), initiating device circuits (IDC), DC power circuits required by various devices, etc.) to the fire alarm devices within its coverage area. The FARP shall provide interconnection services between the device circuits in its area of coverage and the FACP just as if those device circuits were directly connected to the FACP.

F. The Owner shall be responsible for any retrofits, installation and design required by the local AHJ to comply with the requirements of the 2010 Florida Fire Prevention Code, NFPA 1, Section 11.10. This code requirement can only be determined after the construction of the building and may or may not e required by the local AHJ in the area of this project.

1.3 DESCRIPTION

A. The Contractor shall furnish and install a complete addressable analog fire detection (system) (network). The system shall include but not be limited to:

1. Main Fire Alarm Control Panel (FACP) including all required power supplies.
2. Fire Alarm Annunciator Panel (FAAP).
3. Manual Pull Stations.
4. Smoke Detectors.
5. Duct Detectors.
6. Heat Detectors.
7. Combination Audible/Visual devices (indoor and outdoor weatherproof as indicated on the drawings).
8. Visual Devices (indoor and outdoor weatherproof as indicated on the drawings).
9. Remote Fire Alarm Control Panels (Network Nodes).
10. Remote Power Supplies (Remote power supplies shall be in a UL Listed assembly and be provided by the same manufacturer as the Fire Alarm Control Panel (FACP)).
11. "Do Not Use Elevator" warning lights.
12. UL Listed Communicator (DMP: XR500 Panel w/both telephone and network monitoring capabilities).
13. Modem for remote service capabilities.
14. "Areas of Rescue Assistance" Equipment (Areas of Rescue Assistance Equipment shall be provided and installed by the Fire Alarm System Installer).
15. Surge Suppression.
16. Programming.
17. Grounding
18. Firestopping (Firestopping is to be performed under Division 7 Section Firestopping).
19. Wire and Cable Labeling.

20. Electrical power required to comply with all functions and operations called for in this section of the specifications. Contractor shall provide and install all 120 VAC circuits as required.
21. Conduit, wire, wire fittings, terminal cabinets with plywood and terminal strips, and all accessories required to provide a complete operating system.
22. A complete and accurate schematic/drawing of the fire alarm system to be placed adjacent to the fire alarm annunciator panel and the main fire alarm panel.

B. Contractor shall furnish and install all equipment (raceways, wire/cable, circuit breakers, modules, relays, etc.) necessary, and as required by applicable code, to accomplish incidental functions of the fire alarm system including but not limited to the following:

1. Elevator recall, control, and/or shutdown.
2. Monitoring of sprinkler system and/or fire protection system flow and tamper switches.
3. Monitoring of sprinkler system and/or fire protection system valve supervisory switches.
4. Monitoring of post indicator valve (PIV) switches.
5. Gas/Fuel valve shutoff.
6. HVAC system control and/or shutdown.
7. Ventilation system (supply fans, exhaust fans, fan terminal boxes, etc.) control and/or shutdown.
8. Control of fire, smoke, and/or combination fire/smoke dampers.
9. Fire suppression and or extinguishing systems.
10. Monitoring of kitchen hood fire suppression systems.
11. Control of fire and/or smoke doors, dampers, shutters, etc.
12. Control of door hold open devices.
13. Connection to the internet via a local data drop.

C. System shall operate as a non-coded, continuous ringing system which will sound all audible devices and activate all visual devices until it is manually silenced. When system is silenced by silence switch in control panel, audible alarm is to silence but visual alarm devices are to continue to operate.

D. System shall be wired as a Class B system for all circuits.

E. System is to be a complete analog addressable system except for portables. Portables shall be wired as hard-wired circuits.

F. All portions of fire alarm system shall be installed in conduit. Conduit and boxes to be installed by Electrical Contractor.

G. Fire alarm system shall not share a raceway, junction box, enclosure, manhole or device with any other system.

H. Contractor to advise Owner of requirements for monitoring the fire alarm system by Owner's monitoring company and provide all electrical required for remote monitoring including tie to security cabinet.

I. Provide and install wiring, equipment, etc. for connection to devices furnished under other divisions of the work.

J. Provide and install wiring, equipment, etc. as required to deactivate power in the elevator rooms by heat detectors via shunt trip breakers and arm sprinkler pre-action system.

K. Provide and install wiring, equipment, etc. as required to deactivate power to computer power panels and air conditioning equipment by automatic or manual devices as shown on plans.

L. Although they may not be indicated on the fire alarm system diagram and/or drawings, all required control and interlock wiring between the fire alarm system and building equipment shall be provided hereunder. Controls are required to/for/from:

1. Fire/smoke air and duct detectors
2. Fire, smoke and/or combination fire/smoke dampers.
3. Supply/Return fans, Exhaust fans, and/or Fan Terminal Boxes (FTB)
4. Automatic fire extinguishing systems
5. Sprinkler and/or Fire Protection system components

M. Provide wiring for Post Indicator Valve Alarms, in each instance in which these are provided under work of Other Trades, connected to Fire Alarm System.

N. Provide and install all relays (electric-electric, electric-pneumatic, and/or pneumatic-electric) as required for a complete and operational fire alarm system, complying with all applicable codes and all requirements, and coordinated with all divisions of these specifications.

O. Provide terminal cabinets sized to house terminal strips and surge suppression equipment.

P. Surge Suppression

1. The contractor shall have equipment installed on the ac voltage supply and other lines taking care to arrest damaging electrical transient and spikes which can cause damage to the microprocessor components of the system. Central office telephone lines shall have equipment installed to arrest high voltages from electrical and/or lightning from entering the system and causing damage.
2. Provide and install all materials, labor and auxiliaries required to furnish and install complete surge suppression for the protection of building fire alarm system from the effects of induced transient voltage surge and lightning discharge as indicated on drawings or specified in this section.
3. Provide surge suppression equipment at the following locations:
   a) On each conductor pair and cable sheath entering or leaving a building.
   b) On each conductor associated with fire protection (sprinkler) system fire alarm connections.
   c) On any and all telephone lines.
   d) In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to the design of the equipment. Where equipment being protected has internal surge suppression equipment, the surge protection equipment herein specified is required to be installed in addition to internal equipment protection.

1.4 STANDARDS, CODES, REFERENCES, AND REGULATORY REQUIREMENTS

A. Equipment and installation shall comply with the current or applicable provisions of the following standards:

1. ANSI S3.41 American National Standard Audible Emergency Evacuation Signal
2. National Fire Protection Association Standards:
   a) NFPA 70 National Electrical Code (including but not limited to Article 760, Fire Alarm Systems, Article 770 and Article 800)
   b) NFPA 72 National Fire Alarm Code

c) NFPA 101 Code For Safety to Life from Fire in Buildings and Structures

d) NFPA 90A Installation of Air Conditioning and Ventilating Systems

e) NFPA 96 Ventilation Control and Fire Protection of Commercial Cooking Operations

3. Underwriters Laboratories System and all components shall be listed by Underwriters Laboratories for use in fire protective signaling system under the following standards as applicable:

a) UL 864 (Category UOJZ) APOU Control Units and Accessories for Fire Alarm Systems. All Control Equipment shall be listed under UL category UOJZ.

b) UL 268 Smoke Detectors for Fire Alarm Systems

c) UL 268A Smoke Detectors for Duct Application

d) UL 217 Smoke Detectors Single and Multiple Station Smoke Alarms

e) UL 521 Heat Detectors for Fire Protective Signaling Systems

f) UL 228 Door Closers-Holders With or Without Integral Smoke Detectors

g) UL 464 Audible Signal Appliances

h) UL 1638 Visual Signaling Appliances – Private Mode Emergency and General Utility Signaling

i) UL 1481 Power Supplies for Fire-Protective Signaling Systems

j) UL 1480 Speakers for Fire Alarm, Emergency, and Commercial and Professional Use

k) UL 1424 Cables for Power Limited Fire Alarm Circuits

l) UL 1971 Signaling Devices for the Hearing Impaired

m) UL 1449, 3rd Edition Standard for Safety for Surge Protective Devices

n) UL 497 Protectors for Paired-Conductor Communications Circuits

o) UL 497A Secondary Protectors for Communications Circuits

p) UL 497B Protectors for Data Communications and Fire-Alarm Circuits

4. All fire alarm equipment, including accessories to the system and including all wires and cable unless otherwise noted, shall be listed by the Underwriters Laboratories product directory called Fire Protection Equipment and/or the Electrical Construction Materials List.

5. Each item of the fire alarm system shall be listed and classified by UL and FM as suitable for purpose specified and indicated.

6. System controls shall be UL listed for Power Limited Applications per NEC 760. All circuits must be marked in accordance with NEC article 760.

7. All equipment supplied as part of the Fire Alarm System shall be provided by a single manufacturer and shall comprise a complete UL Listed Fire Alarm System.

8. IEEE: Fire alarm system includes solid state electronic components. Therefore, the equipment manufacturer shall provide certification that all such equipment is internally protected from, or can withstand, power line surge voltages and currents as specified in Table 1, Location Category A High Exposure of ANSI/IEEE Standard C62.41 1991.

B. Equipment and installation shall comply with the current or applicable provisions of the following codes and laws:

1. Americans with Disabilities Act (ADA): The fire alarm system shall comply with ADA, Public Law 101-336, 1990 as amended. The system shall comply with ADA Standards for Accessible Design, 2010.
2. Federal Register - Rules and Regulations - Non-discrimination on the basis of Disability by Public Accommodations and in Commercial Facilities.
3. ASME/ANSI A17.1 – Safety Code for Elevators and Escalators.
4. Local and State Building Codes.
    a) Florida Building Code: Latest adopted edition.
    b) Florida Administrative Code. All applicable chapters including but not limited to:
        1. Chapter 69A Rules, including but not limited to:
            (a) Ch 69A-3 Fire Prevention - General Provisions
            (b) Ch 69A-46 Fire Protection System Contractors and Systems
            (c) Ch 69A-47 Uniform Fire Safety Standards for Elevators
            (d) Ch 69A-48 Fire Safety Standards for the Fire Alarm Systems
        2. Florida Administrative Code 453 SREF (Schools)
    c) Florida Fire Prevention Code
    d) Florida Department of Insurance:
        1. Insurance Code: The fire alarm system and installation thereof shall comply with the State of Florida Department of Insurance rules. The requirements of the Florida State Department of Insurance shall be as promulgated by the Division of State Fire Marshal.
        2. Fire Alarm Rules: The fire alarm system and installation thereof shall comply with the Fire Safety Rules promulgated by the Florida State Fire Marshal.
    e) Authority Having Jurisdiction:
        1. General: The system shall comply with all applicable Codes, Ordinances and Standards as interpreted and enforced by the local Authority Having Jurisdiction.
        2. Fire Department (AHJ – Safety, Fire & Health)
        3. Building Official
        4. State of Florida: Division of State Fire Marshal.

C. Surge Suppression
    1. Equipment Certification: When available by any one manufacturer, all surge suppression equipment shall be listed by Underwriters Laboratories, shall bear the UL seal and be marked in accordance with referenced standard. Such surge suppression equipment shall be UL listed and labeled for intended use.
    2. Comply with all standards and guides as listed under "References" above.

1.5 RELATED SECTIONS

A. All applicable sections of Division 0, Division 01, Divisions 26, 27 and 28.

B. Applicable sections of these specifications with regard to, but not limited to:
    1. Doors
    2. Exhaust hoods

3. Standpipe and fire hose systems
4. Sprinkler systems
5. Extinguishing systems
6. Ductwork accessories: smoke dampers
7. Building control systems
8. Local Area Sound System
9. Intrusion Detection System (Prewire)

1.6 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum ten years experience and with service facilities within 50 miles of Project.

B. Installer:

1. Company specializing in installing the products specified in this section with minimum ten years experience.
2. The Installer shall be currently licensed by the Electrical Contractors Licensing Board as a Certified Alarm System Contractor I (EF).
3. The installing Contractor shall be a direct sales division of, or the authorized and designated distributor for, a fire alarm system manufacturer.
4. Installing Contractor shall maintain a local staff of specialists, including a Fire Alarm Planning Superintendent, for planning, installation, and service.
5. The installing Contractor shall maintain an office within fifty miles of the project with capability to provide emergency service seven days a week, 24 hour days. The installing Contractor shall have been actively engaged in the business of selling, installing and servicing fire alarm systems for at least ten consecutive years going back from date of bid.

C. Surge Suppression

1. All surge suppression devices shall be manufactured by a company normally engaged in the design, development, and manufacture of such devices for electronics/communications systems equipment.
2. The surge suppressor manufacturer shall offer technical assistance through support by a factory representative and local stocking distributor.
3. Verify proper clearances, space, etc. is available for surge suppressor.

D. Coordination/Project Conditions

1. Verify proper grounding is in place.
2. In installations where the electrical contractor does not provide a counterpoise system in conjunction with the underground raceway system, the fire alarm contractor shall provide a coupling conductor within the fire alarm underground raceway system to run along side fire alarm conductors. Coupling conductors shall be sized according to applicable codes and standards.

E. To establish the type and operating characteristics of the fire alarm system, the equipment specified herein is used as a guide in determining the functions of the fire alarm system. Other equipment will be considered for approval provided the following is submitted in writing by the system installer to the engineer (See Section 26 05 00 Common Work Results on Substitutions):

1. Contractor qualifications (as listed above).

2. Complete lists, descriptions and drawings of materials to be used.
3. A complete drawing showing conduit, conduit sizes, backboxes, number of wires and wire sizes.
4. A complete riser diagram of Fire Alarm System.

F. Acceptable Manufacturers:

1. Basis of Design
   a) Edwards Systems Technology EST-3
2. Acceptable Substitution:
   a) Notifier
   b) Fire Control Instruments, Inc (FCI).
   c) Digital Monitoring Products (DMP).

1.7 SUBMITTALS

A. Submit in accordance with Division 01 and Section 26 05 00 Common Work Results.

B. In addition to requirements of above, the contractor shall submit:

1. Narrative of operation of System as provided. (Submittal will not be reviewed by the A/E without this narrative.)
2. Manufacturer's data on all products, including but not limited to:
   a) Catalog cut sheets.
   b) Roughing-in diagrams.
   c) Installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
   d) Operation and maintenance manuals.
   e) Typical wiring diagrams and risers.
   f) The contractor shall submit test reports, manufacturers' specifications and any other information necessary to determine compliance with material and equipment specifications described herein.
3. Submit floor plans to locate all devices. Wiring diagrams shall include wire and raceway sizes, fire alarm control panels, riser wiring and associated raceway sizes, wiring details, connections and terminal identification. All devices shall be identified by the same applied identification symbol as shown on the contract documents.
4. Submit all load calculations and cable/wire sizing for each branch of the individual fire alarm field circuits. Wire sizing calculations to prove maximum three percent (3%) voltage drop at all ac voltages and maximum eight percent (8%) voltage drop at all DC voltages.
5. Battery sizing calculations.
6. Submit a detailed step by step testing procedure for a component by component system functional checkout and test.
7. Point to point wiring diagrams and block diagrams of system to be installed. Point to point wiring diagrams may be submitted at time of operation and maintenance manuals in lieu of in submittal brochure. Block diagrams shall be required with submittals.
8. Riser diagrams and floor plans showing conduit runs and number of wires. All devices shall be identified by the same applied identification symbol as shown on the drawings.

9. Surge Suppression
    a) Surge protective data for 120 volt power source, power circuit, outside signaling circuit, and exterior incoming circuits from other buildings (if any), and outgoing circuits to other buildings (if any).
    b) Submit Product Data for each type of suppressor:
        1. Dimensions.
        2. Means of mounting.
        3. Compliance with UL Standards referenced.
        4. Compliance with IEEE Standards referenced.
        5. Design type (Hybrid, MOV).
        6. Size of wire leads.
        7. Warrantee.
        8. Performance data showing compliance with performance as specified herein.
        9. Complete schematic data on each suppressor type indicating component values, part number, conductor sizes, etc.
        10. Manufacturer's certified test data on each suppressor type.
        11. Test data from an independent test laboratory.
10. Name, qualifications, etc. of company providing and installing system.
11. Qualifications of installer. Submit proof installer meets specified requirements.
12. Proof of UL Listing. Indicate the UL listing, the UL classification, and NEC insulation type used for each type of wire to be used in installation of fire alarm and communications system.
13. Manufacturer's drawings showing all dimensions (height, width, and depth) for all cabinets used to house system components. Provide catalog pages, mounting details and specification sheets for all fire alarm system components and rough-in boxes.
14. Submit Florida Registered Firm certificate number.
15. Submit Florida Fire Alarm Contractor's license number.
16. Submit Fire Alarm Technician(s) manufacturer's certification.
17. Detailed drawing of the Fire Alarm Control Panels layout indicating the exact arrangement of all zones, including expansion zones.
18. Coordination Drawing: Coordination CAD drawing of building Fire Command room and equipment layout as shown on drawings, with all panel and rack footprints, using actual manufacturer's dimensions, indicating proper clearances.
19. Network:
    a) Complete description data indicating UL listing for all network components.
    b) Complete sequence of operation of all functions of the network.
    c) A list of every network node address.
    d) A list of every address of every device connected to a network node that is provided for purposes of alarm initiation, status monitoring, supervised notification appliance circuits, and auxiliary control.

e) Complete network wiring diagrams for all components and interfaces to equipment supplied by others.

20. All drawings required herein shall be on AutoCAD 2007.

21. Where required by Authority Having Jurisdiction submit signed and sealed documents as required by Authority Having Jurisdiction. Where Authority Having Jurisdiction requires shop drawings to be signed and sealed by a registered engineer, Contractor is required to submit same and include in his bid all costs associated with having a registered engineer other then the design engineer of record perform signing and sealing.

1.8 PROJECT RECORD DOCUMENTS

A. Submit in accordance with Division 01, Section 26 05 00 Common Work Results and Section 26 01 00 Operation and Maintenance Manuals.

B. In addition to the requirements above, the contractor shall submit:

1. Updated and revised contract documents to record actual locations (as-installed) of all equipment, devices, initiating devices, signaling appliances, and end-of-line devices.

2. Record actual type, size, and routing of cables installed.

3. Record all cable identifications.

4. Drawings required herein are in addition to those required under Operation and Maintenance Data.

5. All drawings required herein to be on AutoCAD Release 2007.

1.9 OPERATION AND MAINTENANCE DATA

A. Submit in accordance with Section 26 05 00 Common Work Results and Section 26 01 00 Operation and Maintenance Manuals.

B. In addition to the requirements of sections above, the Contractor's O & M Manuals shall include:

1. A complete as-installed equipment list, listed by room, with manufacturers' names, model numbers, serial numbers, and quantities of each item.

2. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers and layouts, and other designations and codings (point-to-point wiring diagrams). System performance measurements shall be documented as noted elsewhere in this specification.

3. Riser diagrams showing as-installed conduit with pull boxes, outlet boxes, physical cable layouts, part numbers of cable types used, and number of circuits in each conduit.

4. Repair parts list for each and every major equipment item furnished.

5. Service manuals for each and every major equipment item furnished.

6. Manufacturer's warranties and operating instructions for each and every equipment item furnished. Include a copy of the certificate of warranty, signed by both parties.

7. Technical Systems Operations Manual, custom-written by the Contractor, for the purpose of instructing the Owner's operating personnel in the detailed step-by-step operation of the system and preventive maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.

8. Surge Suppression:

a) O & M data to include:

1. All accepted shop drawings, product data, and/or cutsheets.

2. Installation, connection, and maintenance information on each type of surge suppression.

3. Procedure and/or time table for recommended periodic inspection of devices to determine continued usefulness.

9. Complete equipment rack layouts showing locations of all rack mounted equipment items.

10. CAD floor plans, prepared at a scale of not less than 1/16" = 1'-0" showing detectors, speaker locations and orientation, rack locations, and all other related device locations.

11. The Contractor/Installer shall videotape the entire training session(s), and submit the video tape with the Operational Manual.

C. Drawings required herein are in addition to those required under Project Record Documents.

1. All drawings required herein shall be on AutoCAD Release 2007.

1.10 WARRANTY

A. Contractor shall warrant the equipment to be new and free from defects in material and workmanship, and will, within one year from date of acceptance by Owner, repair or replace any equipment found to be defective.

1. No charges shall be made by the installer for any labor, equipment, or transportation during this period to maintain functions.

2. Respond to trouble call within twenty-four hours after receipt of such a call.

B. Contractor shall guarantee all wiring and raceways to be free from inherent mechanical or electrical defects for one year from date of final acceptance of the system.

C. Surge Suppression

1. All surge suppression devices shall be warranted to be free from defects in materials and workmanship for a period of five years.

2. Any suppressor which shows evidence of failure or incorrect operation during the warranty period shall be repaired or replaced by the manufacturer and installer at no cost to the Owner.

3. Equipment that is damaged by surges during warrantee period shall be replaced at no expense to Owner.

1.11 ADDITIONAL DEVICES FOR JURISDICTIONAL COMPLIANCE

A. Prior to bid, Contractor shall review plans and specifications carefully for compliance with all codes, and in particular the ADA requirements and NFPA 72. Contractor shall include in bid price any devices required to provide a fully compliant system. Said additional devices shall be shown on shop drawings submitted by Contractor.

B. In addition to the above-mentioned devices, Contractor shall include in his bid price the cost of installing twenty additional audible/visual notification devices (over and above those shown on drawings, required by specifications, or determined by system installed to be required) whose location/need may not become apparent until just prior substantial completion date. At least two weeks prior to substantial completion system shall be fully operational. After system is operational Safety Representative and the system installer shall review the placement of and coverage provided by visual and audible signals throughout the facility for compliance with all codes and in particular, the ADA requirements and NFPA 72. System installer shall provide the additional devices at locations where the Architect/Engineer requests for complete coverage. The additional devices shall be installed and fully operational prior to date of Substantial Completion.

C. After the project has had its first annual safety inspection, the system installer shall install within one weeks notice any additional audible/visual signals that have been determined to be

required during said inspection from the balance of the twenty additional devices noted above. There shall be no cost for these added devices provided the total does not exceed the balance remaining of the twenty devices noted above. The final balance of the twenty additional devices included in bid price shall be turned over to the Owner as spare material after any fire alarm issues identified during the first annual safety inspection are resolved.

1.12 MAINTENANCE SERVICE

A. Furnish service and maintenance of fire alarm system for one year from date of Substantial Completion.

1. No charge shall be made by the installer and/or contractor for any labor, equipment, or transportation during this period to maintain functions.

2. Respond to trouble call within twenty-four hours after receipt of such call.

B. Provide annual testing and inspection of fire alarm system at end of first year in accordance with NFPA 72. Correct any deficiencies found at no cost to the Owner. Affix fire alarm tag to panel.

1.13 MAINTENANCE MATERIALS

A. Provide six (6) keys of each type.

B. Provide three (3) of each type of automatic smoke detector without base.

C. Provide three (3) of each type of surge suppression device.

1.14 PROGRAMMING

A. Contractor shall provide all programming (one original copy on disk or CD ROM of the programming software as provided by the manufacturer) EPROM burners, specialty hardware (excluding generic computer), all access codes and copyrighted software needed for adding, deleting and changing devices in the program, for the Owner's use.

1.15 OWNER'S INSTRUCTION:

A. Provide instruction to the Owner's designated personnel upon completion of the system installation. Instruction shall include a functional training session on fire alarm control panel operation and instruction on peripheral device operation, including what are normal indications and alarm indications of each type of new/added device. Videotape all training sessions and deliver four copies of tapes to Owner (for use in future training).

B. Contractor shall include in his bid all expenses to send two representatives to the "End-User Certification Factory Training Course," at the manufacturer's factory. The course shall be specifically designed to allow representatives the skills they need to successfully design, input, and modify, a database that will control the Fire Alarm System. The course shall also provide the skills to install, service and maintain the Fire Alarm System; Factory training for Representative shall be completed prior to substantial completion of the project. Training shall provide instructions, licensed software, access codes, documentation program material, non-assignable and non-exclusive license for in-house use of the licensed software, and any other requirement to allow Owner the capability to add, delete or change devices in the program for the fire alarm-detection system.

1.16 SYSTEM OPERATION

A. System operation shall meet the operation requirements of all codes and regulatory requirements.

B. Upon activation of the fire alarm system by a manual station, smoke detector, or any other new or existing automatic device the following shall take place:

1. Energize all alarm signaling devices.

2. Sound all audible alarms and flash visual signals throughout the campus.

3. Alert proprietary system.
4. Cause alarm to be displayed on the annunciator section of the control panel.
5. Cause alarm to be displayed on remote annunciator
6. Close all doors or fire shutters, held open by automatic release devices throughout the facility, (coordinate with architect and door hardware supplier, provide all electrical required).
7. Unlock all electrically locked time-out room doors (coordinate with the architect and door hardware supplier, provide all electrical required).
8. Shut down all air handlers, exhaust fans supplying or exhausting air, and fan terminal boxes (FTB).
9. Shut all fire and/or smoke dampers in ducts associated with the air handling units and exhaust fans which are shut down.
10. Transmit signals to the building elevator control panel to initiate return to the main floor or alternate floor.
11. Transmit signals to the building automation system to tell system that the fire alarm system has taken control of respective mechanical system.
12. Send a signal to all dimming and lighting relay/control systems. Fire alarm signal shall initiate dimming system controls to drive all dimmed circuits to immediate full-on output. Fire alarm signal shall initiate lighting relay/control system to turn on all emergency lighting circuits.
13. Send a signal to all non-fire alarm sound reinforcement systems (i.e. Cafeteria, Gymnasium, Multi-Purpose Room, Theater, etc.). Fire alarm signals shall override all other sound systems. Alarm notification signals shall take precedence over all other signals. Operation of other sound systems shall resume after fire alarm system clears alarm.
14. Activate the system dialer and transmit the signal to the monitoring contractor, to notify the local fire department.

C. System supervisory faults, such as shorts, opens, and grounds in conductors, operating power failure, or faults within supervised devices, shall place the system in the trouble mode, which causes the following system operations:

1. Visual and audible trouble signal indicated by zone at the fire alarm control panel.
2. Visual and audible trouble signal indicated at remote annunciator panel.
3. Trouble signal transmitted to central station.
4. Manual acknowledgement function at fire alarm control panel shall silence audible trouble signal; visual signal shall be displayed until initiating failure or circuit trouble is cleared.

D. Alarm Reset: The system shall remain in the alarm mode until manually reset with a key accessible reset function. The system shall reset only if the initiating circuits are cleared.

E. Lamp Test: manual lamp test function causes alarm indication at each lamp on the fire alarm control panel and the remote annunciator.

F. When the fire alarm system is activated as a drill, all incidental functions shall be exercised including notification of the fire department.

G. Where required by codes or Authority Having Jurisdiction:

1. When system is silenced by silence switch in control panel, audible alarm is to silence but visual alarm devices are to continue to operate.

H. Fire sprinkler valve tamper switch, when closed, shall annunciate a supervision signal at the fire alarm control panel and annunciator panels, if any. This supervision signal shall not cause a general alarm.

I. Operation of auxiliary contacts in control panel to shut all smoke dampers in ducts associated with air handling units and exhaust fans which are shut down. (These shall not be controlled from detector unit contacts.)

1.17 ZONING

A. Alarm Zones.

1. Regardless of the number of zones shown on drawings, the minimum alarm zones required are:

a) One per building, per floor for pull stations.

b) One per building, per floor for automatic devices.

c) One for each duct smoke detector).

d) Each device shall be individually annunciated/addressable.

B. Notification Zones.

1. Regardless of the number of zones shown on drawings the minimum notification zones (horns and strobe lights) required are:

a) One (or more) circuit(s) for administration building

b) One (or more) circuit(s) for exterior horns

c) One (or more) circuit(s) for remainder of campus.

2. Breakdown circuits as required for load and distances involved.

PART 2 - PRODUCTS

2.1 GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS

A. All equipment shall be new and unused. All components and systems shall be designed for uninterrupted duty. All equipment, materials, accessories, devices, and other facilities covered by this specification or noted on the contract drawings shall be the best suited for the intended use and shall be provided by a single manufacturer.

2.2 RACEWAYS

A. General:

1. All raceways (conduit, wireways, pullboxes, outlet boxes, etc.) shall comply with applicable requirements of sections within Division 26 of these specifications.

2. All raceways (conduit, wireways, pull boxes, outlet boxes, etc.) shall comply with all requirements of the manufacturer of the fire alarm system.

B. Conduit: Comply with Section Conduit except as noted below:

1. Pull Cords: Install pull cords in all raceway runs that are installed without cable.

2. Size: Minimum size shall be 3/4" conduit.

C. Boxes:

1. All outlet boxes, junction boxes, pull boxes, etc. shall comply with applicable section of these specifications.

2. Boxes shall be sized as required by the fire alarm system manufacturer and NEC for cables and/or device installed.

D. J-Hooks:

1. Provide size as required for cables with maximum fill of 50%.
2. Provide mounting/fastener as required for installation.

2.3 TERMINATION CABINETS

A. Terminal cabinets are to comply with applicable sections of these specifications.

2.4 "SYSTEMS" AND "LOCAL" GROUND BUS

A. Bus to comply with applicable sections of these specifications.

2.5 FIRE ALARM CONTROL PANEL (FACP)

A. General

1. Fire alarm control panel shall be of dead front construction and be modular in design. Control panel shall be capable of future expansion and shall provide active signal initiating as noted on drawings (or as herein) specified with zones as noted on drawings (or as herein specified). Control panel shall provide provisions for future expansion. Fire alarm control panel shall be semi-flush mounted (unless otherwise noted on drawings) and located as shown on the drawings.

B. System Capability

1. Communication with addressable devices: The system must provide communication with all initiating and control devices individually. All of these devices are to be individually annunciated at the control panel. Annunciation shall include "Alarm", "Trouble", "Open", "Short", "Ground", "Device Fail" or "Incorrect Device" conditions for each point.
2. All addressable devices are to have the capability of being disabled or enabled individually.
3. Each Signal Line Circuit (SLC) two-wire loop shall be capable of addressing a minimum of ninety-nine addressable devices and ninety-eight monitor or control modules.
4. Identification of Addressable Devices: Each addressable device must be uniquely identified by an address code entered on each device at time of installation. The use of jumpers to set address will not be acceptable due to the potential of vibration and poor contact.
5. Wiring Type, Distances, Survivability and Configurations: The system must allow up to 2,500 feet wire length to the furthest addressable device. Style 4 Signaling Line Circuit (as defined by NFPA-72) communications will be provided.
6. System shall be capable of addressable devices and conventional devices within the same system.
7. All system circuits shall be inherently power limited per NEC 760.
8. System shall be capable of communication with a minimum of fifteen remote module locations.

C. Master Controller

1. Master controller shall be an integral part of the control panel and be microprocessor-based.
2. Master controller shall store all programming in non-volatile memory.
3. Master controller shall have an event log capable of storing a minimum of two hundred fifty-five events in non-volatile memory.
4. Master controller shall include an eighty character Liquid Crystal Display.

5. Master controller shall include, as a minimum, switches to accomplish Alarm/Trouble Acknowledge, Alarm Silence, Trouble Silence and System Reset.
6. Master controller shall include, as a minimum, LEDs to indicate System Alarm, System Trouble, Supervisory Alarm and System Silence.
7. Master controller shall support connection of serial remote annunciators.
8. Master controller shall provide a minimum of two notification appliance circuits (Class A or B, Style Z or Y).
9. Master controller shall be capable of being expanded as necessary to accommodate all required modules.

D. Notification Appliance Circuits

1. Notification Appliance Circuits Module shall provide fully supervised style Z or Y (Class A or B) indicating circuits. These circuits shall supervise and power polarity reversing loops containing up to 1.75 amperes of 24 Volt notification devices.
2. Module shall be provided with plugable contact wiring terminal strips for ease of installation and service. The terminal strips shall be UL listed for 12 AWG wiring.

E. Control panel shall include all equipment required to alert fire department and/or Owner's monitoring service via the XR500 Command Processor Panel.

F. Power Supply

1. Power supply for the panel and all fire alarm peripheral shall be integral to the control panel. Power supply shall provide all control panel and peripheral power needs as well as 3.0 amperes of unregulated 24 VDC power for external audio-visual devices. Audio-visual power may be increased as needed by adding additional modular expansion power suppliers. All power supplies shall be designed to meet UL and NFPA requirements for power-limited operation on all external signaling lines, including initiating circuits and indicating circuits.
2. All power supplies shall be provided by the same manufacturer as the fire alarm control panel (FACP). Power supplies provided by manufacturers other than the manufacturer of the fire alarm control panel (FACP) shall not be acceptable.
3. Circuit breakers, or other over-current protection on all power outputs.
4. Input power shall be 120 VAC, 60 Hz. Power supply shall provide internal batteries and charger. Internal battery capacity shall be as required.
5. Battery pack shall provide maximum normal operating and supervisory power for:
    a) 24 hours per NFPA 72
    b) Provide low maintenance gel cell type batteries with sufficient ampere-hour rating to meet the above NFPA Standard and to operate all alarm signals for a duration of 15 minutes at the end of the required period of time.

G. Modem

1. A modem shall be provided as an integral part of the fire alarm control panel (FACP). The modem shall provide the Owner with the ability to accomplish the following functions:
    a) View device sensitivity information.
    b) View system activity in real time.
    c) Access and view the system history log.
2. Modem shall not allow changes to system programming.
3. Modem shall operate at a minimum speed of 9600 baud.

4. Modem shall provide an RJ-11 connector for connection to a telephone line.
5. Fire alarm contractor shall coordinate with the Premise Distribution System (PDS) contractor and/or the Telephone System contractor for interconnection to a telephone line. Telephone interconnection wiring up to the modem shall be provided by the PDS or Telephone contractor.
6. The modem shall mount inside the fire alarm control panel (FACP).

H. Wall Mount Equipment Enclosure

1. The control panel, and all associated equipment, shall be housed in an enclosure designed for mounting directly to a wall or vertical surface. The back box and door shall be constructed of 16 gauge steel with provisions for electrical conduit connections into the sides and top. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators.
2. The enclosure(s) shall be of sufficient size to house all equipment required for this project. All equipment shall be mounted in the enclosure(s) as designed by the manufacturer. Provide enclosures in quantities as required to provide a complete, UL Listed Fire Alarm system.

2.6 COMMUNICATIONS PANEL

A. Communications panel is to be a Digital Monitoring Products (DMP) XR500 Series Command Processor Panel. Approved suppliers: NuTech National, Orlando, Florida, Advanced Engineering Systems (AES), Longwood, Florida and Site Secure, Sanford, Florida.

B. Panel shall be capable of communicating with two or more monitoring stations using both telephone and network monitoring systems.

C. Panel shall be powered separately from the Main Fire Alarm Control Panel (FACP) and have its own back-up battery.

D. Panel shall receive from the Fire Alarm Control Panel inputs for Alarm, Supervision and Trouble.

2.7 REMOTE ANNUNCIATOR

A. Fire Alarm Annunciator Panel (FAAP) shall be a serial annunciator panel and must be capable of being mounted in a remote location.

B. Annunciator shall be modular using low current circuitry. The annunciator shall be capable of operating on nominal 24 Vdc and be battery backed up.

C. Annunciator modules shall be capable of activating local or remote LEDs, relays or graphic panels.

D. All switches shall be a point in the system and be capable of controlling any system output or functions. All LEDs and outputs shall be capable of being controlled by any change of state in the system or as a result of a time control, sequence or logic function. LEDs and switches shall be able to be clearly marked by the end user.

E. Modular components of the annunciator shall be mounted in a recessed cabinet with hinged door and a lexan window with keylock.

2.8 VOICE EVACUATION SYSTEM

A. The voice evacuation system shall provide 50 or 100 Watt signal power and 50 or 100 Watts voice power as required, and shall be UL listed.

B. All speaker circuits shall be field selectable for 25 or 70 Vrms operation and shall be power limited. Non-power limited circuits are not acceptable.

C. The voice evacuation system shall be microprocessor based, and shall contain an integral microphone, 50 or 100 Watt audio amplifier (as required), tone generator, digital message repeater, 120 VAC power supply, and battery charger.

D. The voice evacuation message/signal shall be broadcast until the Fire Alarm Control Panel (FACP) is reset, or until fire emergency personnel interrupt the broadcast with a manual page. On reset system shall automatically return to standby (normal operating) condition.

E. A secondary message shall be provided that can be triggered by the closure of a contact from either the FACP or from any normally open contact device.

F. Remote paging microphone(s) will be supported by the system through a supervised circuit. Remote microphone(s) may be mounted up to 5,000 ft. (1,524 m) away from the voice evacuation panel.

2.9 MANUAL STATION (NON-BREAK GLASS)

A. Manual fire alarm station shall be non-code, non break glass type providing noncoded signals and operating with a double action motion. Upon actuation, they shall not be restorable to normal except by use of a key. The key shall also allow stations to be tested nondestructively. The stations shall be constructed of metal, with operating directions provided on the cover in highlighted, embossed lettering. The words "FIRE ALARM" shall appear on the door in embossed letters one-half inch high or larger. Mount at 48" above finished floor to top and in accordance with NFPA and handicap standards. Manual stations shall be UL listed. Unit shall be equipped with an addressable interface module. Stations constructed of plastic will not be acceptable.

2.10 PHOTOELECTRIC SMOKE DETECTOR

A. The contractor shall furnish and install Analog addressable photoelectric smoke detectors, as called for on drawings. The combination detector head and twist-lock base shall be UL-listed compatible with a UL-listed fire alarm panel.

B. Smoke detector shall have a flashing, status-indicating LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady and at full brilliance. The detector may be reset by actuating the control panel reset switch.

C. Sensitivity of the detector shall be monitored without removal of the detector head. Metering test points shall be accessible on the exterior of the detector head. Field adjustment of the sensitivity shall be possible when conditions require a change.

D. Vandal-resistant, security locking feature shall be used in those areas as indicated on the drawings. Locking feature shall be field removable when not required.

E. It shall be possible to perform a functional test of the detector without the need of generating smoke. Test method must simulate effects of products of combustion in the chamber to ensure testing of all detector circuits.

F. To facilitate installation, detector shall be nonpolarized. By using a furnished wire jumper, it shall be possible to check circuit loop continuity prior to installing the detector head.

G. Voltage and RF transient suppression techniques shall be employed to minimize false alarm potential. A gated alarm output shall be used for additional detector stability.

2.11 DUCT MOUNTED SMOKE DETECTOR

A. Duct Mounted Smoke Detector for the fire and smoke detection system shall be a high velocity rated Analog addressable series smoke detector intended for use with ventilation and conditioning ducts.

B. Detector shall provide detection of combustion gases and smoke in air conditioning ducts in compliance with NFPA 90A. Detector shall be UL-listed specifically for the use in air handling systems.

C. Detector shall operate at air velocities raging from 300 feet per minute to 4000 feet per minute without requiring compensation for operation at specific air velocities. Sampling tubes of proper length shall be provided and installed to match duct width at the installed location.

D. Whether shown on drawings or not, a remote alarm indicator/test station shall be provided for each duct mounted smoke detector to annunciate smoke detector operation remotely. Mount unit in ceiling or wall near respective remote smoke detectors (in an occupied space).

E. Detector shall be zoned so that when either the supply or the return detector senses smoke it will cause a supervisory/trouble indication at the main fire alarm panel and immediately shut down the air handler. The duct mounted detectors are NOT to cause a general alarm to sound.

2.12 HEAT DETECTORS

A. Contractor shall furnish and install Analog addressable heat detectors, as called for on drawings. Combination detector head and twist-lock base shall be UL-listed compatible with a UL-listed fire alarm panel.

B. Heat detector shall have a flashing, status-indicating LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady and at full brilliance. Detector may be reset by actuating the control panel reset switch.

C. Fixed temperature automatic heat detectors shall be rated at 135°F (unless otherwise noted or required due to ambient conditions; i.e., Kiln Room). Fixed temperature element shall use dual thermistor technology. Detectors shall have a smooth ceiling rating of 900 square feet. When required, detectors shall be equipped with two Form 'A' contacts with rating of 3 amps at 6 to 125 volts A.C. and 1 amp at 6 to 28 volts DC.

D. Detectors shall be installed in accordance with appropriate articles of National Fire Protection Association and the spacing rating assigned by the Underwriters Laboratories and located as shown on the drawings. Automatic heat detectors shall be Underwriters Laboratories and Factory Mutual approved.

E. Where indicated on the drawings, the Contractor shall provide heat detectors rated, by the manufacturer, as explosion proof. If not an integral part of the heat detector assembly, the addressable module shall be located outside the area protected by the explosion proof heat detector (but interior to the building) in an accessible area. If the addressable module is located above a gypsum board ceiling the Contractor shall provide a fire rated access panel.

2.13 ADDRESSABLE MODULE

A. Analog addressable device shall be furnished as required to monitor fire alarm or supervisory initiating devices or control auxiliary functions. Each module shall contain address switches to assign a unique input point for programming or control by the system.

2.14 RELAYS

A. Relays required for control (i.e. Air Handler shutdown, Supply Fan shutdown, Exhaust Fan shutdown, Fan Terminal Box shutdown, Door Lock release, Fire Shutter release, Smoke Damper closure, Fire Damper closure, Smoke/Fire Damper closure, or any other interface required by these specifications or applicable codes) shall be UL Listed relays suitable for use in Fire Alarm systems.

B. Per NFPA, relays used for control of other systems shall be located within 3 feet of the device to be controlled.

C. Relays shall be analog addressable devices powered and controlled from the fire alarm system. Each relay shall contain address switches to assign a unique input point for programming or control by the system.

D. Each relay shall provide at least one set of Form "C" dry relay contacts.

2.15 AUDIBLE NOTIFICATION DEVICES

A. Audible notification devices shall be wall mounted at each location designated on the drawings and/or as specified herein.

B. The audible notification device shall include screw terminals for in-out field wiring. The device shall surface mount to a standard 4 inch sq. x 2 -1/8 inch backbox.

C. The audible notification devices shall be UL listed for fire protective service and shall provide 24 VDC inputs and sound output of not less than 75 dBA at 10 feet, or more than 120 dBA at the minimum hearing distance from the audible appliance.

1. Audible notification device shall compliant with ANSI S3.41 for signal character conformance.

D. Audible notification devices located on the exterior of a building, or in a damp or wet location, shall be a weatherproof version and rated, by the manufacturer, for use in wet locations.

2.16 AUDIBLE/VISUAL NOTIFICATION DEVICES

A. Audible/visual notification devices shall be wall mounted at each location designated on the drawings and/or as specified herein.

B. Audible/visual notification device shall include screw terminals for in-out field wiring. The device shall surface mount to a standard 4 inch sq. x 2 -1/8 inch backbox.

C. Audible portion of the audible/visual notification devices shall be UL listed for fire protective service and shall provide 24 VDC inputs and sound output of not less than 75 dBA at 10 feet, or more than 120 dBA at the minimum hearing distance from the audible appliance.

1. Audible portion of the audible/visual notification device shall compliant with ANSI S3.41 for signal character conformance.

D. Audible portion of audible/visual notification devices located on the exterior of a building, or in a damp or wet location, shall be a weatherproof version and rated, by the manufacturer, for use in wet locations.

E. Visual portion of the audible/visual notification devices shall comply with the Americans with Disabilities Act which includes the following:

1. Lamp shall be a xenon strobe type or equivalent.

2. Color shall be clear or nominal white (i.e. unfiltered or clear filtered white light).

3. Maximum pulse duration shall be two-tenths of one second (0.2 sec) with a maximum duty cycle of 40 percent. Pulse duration is defined as the time interval between initial and final points of 10 percent of maximum signal.

4. Intensity shall be a minimum of 75 candela. Use of visual devices rated at 15/75, 15 or 30 candela shall not be acceptable.

5. Flash rate shall be a minimum of 1 Hz and a maximum of 3 Hz.

6. More than two visible notification appliances in the same room or adjacent space within the field of view must flash in synchronization. This requirement shall not preclude synchronization of appliances that are not within the same field of view.

F. A suitable polycarbonate cover shall be provided to protect devices at locations where they may be subject to damage such as Gymnasiums.

2.17 VISUAL NOTIFICATION DEVICES

A. Visual notification devices shall be wall mounted at each location designated on the drawings and/or as specified herein. Visual notification devices shall be of the flashing type in compliance with Americans with Disabilities Act.

B. Visual notification devices shall comply with the Americans with Disabilities Act which includes the following:

1. Lamp shall be a xenon strobe type or equivalent.
2. Color shall be clear or nominal white (i.e. unfiltered or clear filtered white light).
3. Maximum pulse duration shall be two-tenths of one second (0.2 sec) with a maximum duty cycle of 40 percent. Pulse duration is defined as the time interval between initial and final points of 10 percent of maximum signal.
4. Intensity shall be a minimum of 75 candela. The use of visual devices rated at 15/75, 15 or 30 candela shall not be acceptable.
5. Flash rate shall be a minimum of 1 Hz and a maximum of 3 Hz.
6. Fire alarm system strobes within same room shall flash in synchronization as required by NFPA.
7. More than two visible notification appliances in the same room or adjacent space within the field of view must flash in synchronization. This requirement shall not preclude synchronization of appliances that are not within the same field of view.

C. A suitable polycarbonate cover shall be provided to protect devices at locations where they may be subject to damage such as Gymnasiums.

2.18 WEATHERPROOF COVER (FOR AUDIBLE AND/OR VISUAL DEVICES)

A. Constructed of clear polycarbonate.

B. For flush or surface mount devices.

C. Provide slotted version for audible/visual devices.

1. Maximum of 5 dB loss.
2. Provide with brass weep hole.

D. Provide unslotted version for visual only devices.

1. Maximum of 3 candela light intensity loss up to 110 candela light source.
2. Provide without weep hole.

E. Provide with weather gasket.

F. Spacers for additional depth as required.

G. Provide with tamper proof screws.

H. Design criteria:

1. Safety Technology International, Inc. #1220 (audible/visual) or #1221 (visual) series.

2.19 PULL STATION SECURITY COVER

A. Provide where pull station devices are required to be protected as indicated on the drawings.

B. Shall be UL Listed.

C. Constructed of clear polycarbonate.

D. Provide with battery operated warning horn.

E. For flush or surface mount devices.

F. Provide with weather gasket.

G. Spacers for additional depth as required.

H. Provide with tamper proof screws.

I. Design criteria:

1. Safety Technology International, Inc. #1100 Series.

2.20 DOOR HOLDERS

A. Electromagnetic door holder/releases shall be installed on each door as detailed on the drawings and/or as specified herein. Holder/releases shall consist of wall mounted and floor mounted electromagnets and a door mounted armature with an adjustable contact plate. Electromagnets shall have a force of attraction of 24 pounds when energized and less than 3 pounds residual power disconnected. Armature contact plates shall have a horizontal adjustment of 25 degrees. The holding force of holder/releases shall be totally electromagnetic and without the use of mechanical linkage or other moving parts, and they shall normally be energized, and a release accomplished, by interrupting the circuit. Electromagnetic holder/releases shall be controlled by either automatic or manual alarm. Operating voltage shall be 24 volt dc.

B. Electromagnetic door holder/releases, where required, to be supplied and installed by the Contractor and wired in to fire alarm system by systems contractor. Electromagnetic holder/releases shall be controlled by either automatic or manual alarm. Operating voltage shall be 24 volt dc.

2.21 SURGE SUPPRESSION

A. Non-Addressable Initiation Devices:

1. Plug-in replacement modular design with associated female wiring connector.
2. UL 497B listed and labeled.
3. Multi-stage hybrid protection circuit.
4. Fail short/fail safe.
5. Surge Capacity: 10KA with 8 x 20 μs waveform, 500A per line with 10 x 700 μs waveform.
6. Clamp Voltage: 150% of circuit peak operating voltage with 100 amp 10 x 700 μs waveform.
7. Maximum Continuous Operating Voltage: 125% of peak operating voltage, minimum.
8. Capacitance: 1500 pf.
9. Manufacturer:
   a) EDCO #PC642C series with #PCBIB base.

B. Addressable Initiation Devices and Data Loops:

1. Plug-in replacement modular design with associated female wiring connector.
2. UL 497B listed and labeled.
3. Multi-stage hybrid protection circuit.
4. Fail short/fail safe.
5. Surge Capacity: 10KA with 8 x 20 μs waveform, 500A per line with 10 x 700 μs waveform.
6. Clamp Voltage: 150% of circuit peak operating voltage with 100 amp 10 x 700 μs waveform.
7. Maximum Continuous Operating Voltage: 125% of peak operating voltage, minimum.
8. Capacitance: 50 pf.
9. Manufacturer:

a) EDCO #PC642C-LC series with #PCBIB base.

C. Horn, Strobe, Control Power (Low Voltage):

1. Plug-in replacement modular design with associated female wiring connector.
2. UL 497B listed and labeled.
3. Multi-stage hybrid protection circuit.
4. Fail short/fail safe.
5. Surge Capacity: 5KA with 8 x 20 μs waveform.
6. Clamp Voltage: 150% of circuit peak operating voltage with 100 amp 10 x 700 μs waveform.
7. Maximum Continuous Operating Voltage: 125% of peak operating voltage, minimum.
8. Series Resistance: 0.2 ohms total per pair.
9. Manufacturer:
   a) EDCO #P164 series (1 pair); #P264 series (2 pair), each with #SD12-PC base.

D. Power Circuit (120 volt):

1. UL 1449 listed.
2. 15 amp, 120V rated.
3. Suppressors shall be tested per IEEE, C62.41-1991 for Categories A and B.
4. Normal mode (L-N), and common mode (L+N-G) protection.
5. Internal fusing.
6. Hybrid design.
7. Indicators for normal operation and failure indication.
8. Enclosure:
   a) Fire retardant high impact, phenolic or plastic housing or metal enclosure.
9. Clamping voltage UL 1449, Line to Neutral, Category B Impulse At (3KA, 8 x 20 μs): 385V @ 120V.
10. Maximum Surge Capacity: 20,000 amps.
11. Maximum Continuous Operating Voltage: 115% of line voltage.
12. Provide hardwire connection or add 15 amp receptacle device to hardwired devices to match equipment being protected and maintain UL listing.
13. Provide additional 15 amp in-line fusing as required to comply with UL and the NEC when connected to a 20 amp, 120V circuit.
14. Manufacturers:
    a) Leviton #51020-WM (hardwired).
    b) EDCO #HSP-121BL2.

E. Terminations

1. Provide terminals sized for circuits required on project.
2. Where surge suppression modules are for mounting on 'M' block assembly, provide M block assembly complete with grounding system that mates with surge suppression equipment.

F. Terminal Cabinets

1. Provide terminal cabinets for all terminations and surge suppression equipment including 120VAC power surge suppressor as required in Section 26 43 00 Surge Protective Devices. Size terminal cabinets as required to facilitate installation of terminations and surge suppression in a neat and workmanlike manner.
2. Terminal cabinet to meet specifications in Section 26 27 16 Cabinets and Enclosures unless specifically manufactured for use.
3. Manufacturers:
   a) Interior.
      1. Square "D"
      2. Hoffman
      3. BUD
   b) Exterior.
      1. Hoffman
      2. BUD
      3. Carlon

2.22 CABLE

A. Contractor shall provide and install cable as required by the manufacturer, as specified elsewhere in these specifications, and to provide a complete, fully operational, UL Listed Fire Alarm system.

B. Fire alarm system cables installed in interior, exterior and/or underground raceways shall comply with the applicable sections of NEC Articles 760, 770 and 800.

C. Zip and zip type cables (e.g. West Penn 970, 971, 972, 974 or similarly constructed cables from other manufacturers) shall not be acceptable.

D. Wiring color code shall be as follows:

1.	Horns/Strobes	Black/Red
2.	Door Holders	White
3.	A.H.S.D.	Purple
4.	Gas Shut-Off Pull Stations	Orange
5.	Addressable	Twisted Pair Data Wire
6.	Hard-Wired	Brown/Blue

2.23 WATERFLOW DETECTOR

A. Water flow switch to be supplied and installed by the mechanical contractor and wired in to Fire Alarm System by systems contractor. Zone as shown on zone schedule.

2.24 SPRINKLER SUPERVISORY SWITCHES

A. Supervisory Switch to be supplied and installed by mechanical contractor and wired in to Fire Alarm System by systems contractor. Zone as shown on zone schedule.

PART 3- EXECUTION

3.1 INSTALLATION

A. Contractor is advised that circuit routing for this system is not necessarily shown on the project drawings. Contractor shall provide and install all raceways, wiring and cabling required for a

complete and fully functional system as intended by these specifications. All wiring and/or cabling concealed within walls or in exposed locations shall be in conduit. Cabling located above lay-in ceilings may be run without conduit provided it is supported on J-hooks dedicated to fire alarm wiring. J-hooks shall be provided at a spacing of 5 feet or less. Contractor shall provide and install a properly sized, flush mounted outlet box for every device. Contractor shall size and route raceways to accommodate the proper installation of the system cabling. T-Tapped cabling shall not be acceptable. In locations where cabling is not accessible after completion of the project, conduit shall be provided. Contractor shall properly terminate each device according to the manufacturer’s recommendations. Provide and install firestopping where penetrations are made through rated walls and floors. Firestopping is to be performed under Division 7 Section Firestopping.

B. Locate, install, and test fire alarm and detection systems in accordance with the equipment manufacturer's written instructions, and the latest editions of the National Electrical Code, the National Electrical Contractor's Association publication "Standard of Installation" and all applicable codes and standards referenced in this specification.

C. Provide all work required for a complete system including complete system testing and checkout. All components shall be properly mounted and wired. The installation of this system shall comply with the directions and recommendations of authorized factory representatives.

D. Provide wiring, cabling, raceways, and electrical boxes in accordance with manufacturer's written instructions.

E. Components shall be electrically "burned-in" by operating the component at full power for a period as recommended by the manufacturer.

F. Installation shall be done in a neat workmanlike fashion by a firm regularly engaged in Fire Alarm Installation and Service.

G. The installation and inspection of all fire detection and fire alarm devices and systems shall be performed by, or under the direct on-site supervision of, a licensed fire alarm technician or a fire alarm planning superintendent who shall certify the work upon completion of the activity. The certifying licensee shall be present for the final test prior to certification.

H. As-built plans and wiring diagrams shall bear the signature and license number of the licensed fire alarm planning superintendent, the date of installation and the name, address, and certificate-of-registration number of the registered firm.

I. All components shall be completely wired. System shall be fully operable via battery power when main power service has failed.

J. Installation of detectors:

1. All ceiling mounted detectors shall be installed in accordance with the requirements of NFPA 72.

2. All concealed detectors shall be provided with a remote indicating lamp and test switch installed in an occupied space (corridor, etc.) on wall or on the ceiling grid indicating the type of detector and the zone to which it is connected. Label shall be red with white lettering.

3. Duct detectors shall be installed in accordance with NFPA 90A. All brackets and hardware shall be provided as required to install detector housing in correct position. All detector housings shall be sealed as required to prevent air leakage between duct and housing. Sampling tubes of proper length shall be provided and installed to match duct width at the installed location.

3.2 RACEWAYS AND BOXES

A. Provide dedicated raceway with applicable boxes for all fire alarm wiring concealed within walls , installed exposed or installed in inaccessible locations in accordance with applicable sections of these specifications.

B. All initiating, indicating and auxiliary control devices shall be mounted on UL listed outlet boxes.

C. Provide supporting devices per Section 26 05 33 Conduit.

D. Identify raceways and boxes per Section 26 05 53 Identification for Electrical Systems.

E. J-hooks shall be dedicated to the fire alarm system and installed at a spacing that does not exceed 5 feet.

3.3 WIRE/CABLE

A. Conductor: 98% conductivity, stranded copper with maximum of 19 strands. Stranded conductors shall have a compression lug installed at every end. Wrapping twisted strands at terminal block screw is not acceptable. As an acceptable equivalent, stranded conductors without crimp-on lugs may be terminated into terminal strips of box-lug connectors. SLC loops may utilize solid conductors.

B. Insulation: A type accepted by NEC for the application. All cable shall be UL listed for fire-protective signaling application. Communication, Class 3 or Multi-Purpose cables shall not be substituted for FP cable types. All multi-conductor cables shall have individually insulated conductors with an overall outer jacket.

C. Size: All conductors shall be sized as prescribed by the system manufacturer, with following minimums:

1. Multiplex Signaling Line Circuit: AWG #14, solid twisted pair within an FPL cable.

2. Notification Circuits, Devices: AWG #14 stranded conductors within an FPL cable.

3. Initiating Circuits, Hard-Wired Devices: AWG #14 stranded conductors within an FPL cable.

4. Initiating Circuits, Addressable Devices: AWG #16 twisted pair within an FPL cable.

5. Provide larger conductors where required to maintain voltage drop or signal strength within acceptable limits.

6. Multiplex signal line circuits and addressable circuits shall be either shielded or unshielded based on equipment manufacturer’s recommendations for specific application.

D. The above wire sizes shall be increased to size as required to comply with Authority Having Jurisdiction or as required for voltage drop, load, etc.

E. Wire Identification:

1. Permanent wire materials shall be used to identify all splices and terminations for each circuit at all junction boxes, outlet boxes, and terminations.

F. UL:

1. General: Fire-protective signaling cable shall be UL listed as non-power limited or power limited as needed to match the output of the fire alarm equipment.

2. Non-Power Limited: Fire protective signaling circuits classified as non-power limited shall use cable listed under UL Electrical Construction Materials Directory. Category HNHT, "NON-POWER LIMITED FIRE-PROTECTIVE SIGNALING CABLE". All such cable shall have fire resistance, listing and markings as described in NEC 760.176. Minimum cable marking shall be NPLF.

3. Power Limited: Fire protective signaling circuits classified as power limited shall use cable listed under UL Category HNIR, "POWER LIMITED FIRE-PROTECTIVE SIGNALING CABLE". All such circuits shall be durably marked where plainly visible at terminations to indicate that it is a power-limited fire protective signaling circuit. Refer to paragraph titled "Fire Resistance of Cables" for additional requirements.

4. Fire Resistance of Cables: Power-limited fire-protective signaling circuit cables shall be UL listed as described in NEC 760.179. All such cable shall bear a cable marking that includes a Type designation as given in NEC 760.179(I). Provide Type FPL.

G. Connections of Installation Wiring:

1. Connections to Equipment: In accordance with NFPA for monitoring integrity and with the equipment manufacturer's instructions.

2. Connections of installation wiring to alarm initiating devices and alarm indicating appliances shall be monitored for integrity.

3. Interconnecting means shall be arranged so that a single break or single ground fault will not cause an alarm signal.

4. Apply a compression lug, similar to T&B Sta-Kon Terminal, to all stranded conductors at terminations or use box-lug terminal strips.

5. There shall be no wire splices. All wiring shall be continuous, uncut between devices and terminal blocks.

H. Rated Enclosures:

1. All vertical fire alarm wiring traversing more than one level shall be routed in rated enclosures. In addition, all horizontal wiring serving devices located on floors other than where wiring originates shall be routed in 2-inch concrete encasement, suitable rated building construction, or 2-hour wrap application enclosure accepted by local Authority Having Jurisdiction.

3.4 MANUAL PULL STATIONS

A. Install at 48 inches to top above finished floor.

B. All manual stations shall be in unobstr ucted locations.

C. Install to comply with NFPA, ADA, and all handicap/accessibility code requirements.

D. Provide, install, and connect additional pull stations (from that shown on drawings) as required to comply with above requirements.

3.5 AUDIBLE SIGNAL DEVICES, VISUAL SIGNAL DEVICES OR COMBINATION AUDIBLE/VISUAL SIGNAL DEVICES

A. Shall comply with NFPA, the Americans with Disabilities Act and other applicable handicap/accessibility codes including but not limited to the following:

1. Wall mounted devices shall have their bottom edge at heights above the finished floor of not less than 80” and no greater than 96”.

2. In general, no place in any room or space required to have a visual signal appliance shall be more than 50’ from the signal (in the horizontal plane). In large rooms and spaces exceeding 100’ across, without obstructions 6’ above the finished floor, such as auditoriums, devices may be placed around the perimeter, spaced a maximum 100’ apart, in lieu of suspending appliances from the ceiling. Placement of visual devices shall not be less than the requirements as specified by NFPA 72.

3. No one place in common corridors or hallways in which visual alarm signaling appliances are required shall be more than 50’ from the signal. Placement of visual devices shall not be less than the requirements as specified by NFPA 72.

3.6 END-OF-LINE DEVICE

A. Mount end-of-line device box with last device or separate box adjacent to last device in circuit.

3.7 AUXILIARY CONTROL RELAYS

A. An auxiliary fire alarm relay used to control an emergency control device, e.g. motor controller for HVAC system fan or elevator controller shall be located within 3’ of the emergency control device.

B. The installation wiring between the system panel and the auxiliary fire alarm relay shall be monitored for integrity.

C. Auxiliary control relays shall be listed for use with fire alarm systems.

3.8 SPRINKLER FLOW SWITCHES

A. Coordinate the electrical and operating characteristics of the flow switches with the fire alarm panel.

B. Run conduit and wiring to the flow switches, and connect them so as to provide an operable supervised sprinkler alarm system per NFPA standards, and state and local codes.

C. Provide all electrical including zones as required by Authority Having Jurisdiction and codes.

3.9 SPRINKLER VALVE SUPERVISORY SWITCHES

A. Coordinate the electrical and operating characteristics of the supervisory switches with the fire alarm panel.

B. Run conduit and wiring to the supervisory switches, and connect them so as to provide an operable supervised sprinkler alarm system per NFPA standards, and state and local codes.

C. Provide all electrical including zones as required by Authority Having Jurisdiction and codes.

3.10 DOOR ELECTRIC LOCK AND HOLD-OPEN POWER SYSTEMS

A. General: Provide 24V-dc low voltage power to all building doors with openers, hold-open devices, closers or electric locks. Refer to Architectural door hardware schedule for doors that may have electric holders or locks. Low voltage power supplies for door hardware shall be furnished separately from the fire alarm system. The fire alarm system shall only provide the unlocking or release control signals and auxiliary control relays at power supplies, in order to reduce power draw on fire alarm system power supplies and batteries.

B. Low Voltage Power: Provide a low voltage transformer on each floor having doors with electric hardware. Transformer shall be 120-24 Vac, sized as required to handle load served. Mount in a NEMA 1 enclosure above accessible corridor ceiling outside the first door closest to fire alarm riser. Provide transformer primary fusing to comply with NEC. Provide a 24 Vac-24 Vdc rectifier on the secondary side of the transformer. Provide dedicated branch circuit from closest 120V normal power panel. Provide necessary interposing auxiliary control relay(s) to accept unlocking/release and restore signals from the fire alarm system.

C. Wiring: Electric hardware shall be connected for fail-safe operation. Upon loss of normal power hardware shall unlock without unlatching. Hold-open doors shall release for closure. Restoration of hardware power shall be automatic after the fire alarm system unlock control is reset. Provide all wiring necessary to connect transformer. Provide all low voltage wiring to connect electric locks. Extend wiring down hinge side of stair door jam through hinge plate into door and through door to electric lock mechanism.

D. Fire Alarm Unlocking Control: All door hardware circuits shall be controlled by fire alarm system. Upon receipt of signal from fire alarm system all door holders shall release and stair/egress door electric locks power system shall be disabled allowing all locks to unlock (without unlatching). Signal to activate shall be automatic fire alarm signal or manual command initiated in the building Fire Control Room. Manual unlock override command shall be through override system. Reference paragraph entitled "FIRE DEPARTMENT OVERRIDE CONTROL PANEL". Provide pilot light and three-position override switch. ON position (illuminated red pilot light) shall initiate fail-safe operation. OFF position shall restore low voltage power. Provide separate override switch for door openers associated with Atrium Smoke Exhaust System.

E. Mount outlet box for electric door holder to withstand 80 pounds pulling force.

3.11 GAS/FUEL SHUT-OFFS

A. Whether shown on drawings or not provide gas/fuel shut-off systems for each and every gas/fuel supply as required by the applicable codes and standards.

3.12 CABLE IDENTIFICATION

A. Provide and install permanent cable markers on all cables/wire lines, telephone lines, etc. at terminal strips, terminal cabinets and at main equipment.

3.13 INTERNET CONNECTION

A. Provide a connection from a data outlet (RJ45 connector) mounted adjacent to the FACP to the nearest PDS rack for connection to the internet. Provide and install the DMP: XR500 Communications Panel as required for communication to the Fire Alarm Monitoring Contractor

3.14 SURGE PROTECTION

A. General

1. Provide, install and connect new surge suppression equipment as specified herein, including protection of equipment power source, cable/wire entering or leaving building housing, main fire alarm system equipment, ground lugs, #6 copper ground wire in 3/4" C. to existing main building service ground.
2. Extreme care shall be taken by contractor to assure a properly surge protected system.
3. Surge protection equipment must be selected by contractor to match the equipment being protected including wire sizes, operating volts, amps, and circuit impedance.
4. Installation of surge protection equipment and its grounding must be per manufacturer's recommendations to assure short and proper ground paths.

B. Equipment Selection

1. Contractor to coordinate with suppliers and installers of all equipment being protected and provide surge suppression equipment which meets these specifications on respective equipment, wires, etc.

C. Equipment Installation

1. Install surge suppression equipment per manufacturers recommendation at each wire terminal as noted under Part 1.
2. Install in surge suppression equipment terminal cabinets, etc. as required to facilitate installation of surge protection equipment and terminal points. Increase size of terminal cabinets (from that shown on drawings) to size required to facilitate installation of surge suppression equipment and terminal blocks.
3. Locate surge suppression equipment in terminal cabinet nearest main equipment cabinet (FACP).
4. Coordinate with Section Surge Suppression Equipment Contractor to assure that surge suppression for 120VAC power circuit and surge suppression required by this section are all installed in same terminal cabinet and bonded together.

D. Ground Installation

1. Ground Bus Connections.

a) Provide "local" ground bus in each terminal cabinet housing surge protection equipment (with lugs, etc. as required).

b) Bond "local" ground bus to terminal cabinet with minimum #6 copper wire.

c) Connect terminal cabinet "local" ground bus to "systems" ground bus installed per Section Grounding and Bonding with minimum #6 copper insulated wire (unless otherwise noted) in conduit.

d) Note that "systems" ground bar is also to be used for power transformation ground (480V to 208V) where applicable.

2. Surge suppression equipment grounding.

a) Connect each surge suppressor to local ground bus in terminal cabinet with wire sized as recommended by manufacturer. Where "M" block type terminations/surge suppressors are used, bond ground rail to local ground bar with wire as recommended by manufacturer.

b) Coordinate with Section Surge Protection Devices Contractor to assure that 120VAC power source/supply surge suppressor is also grounded to same local ground bus as surge suppressors provided in this section for same system (i.e. fire alarm, intercom, television, etc.).

3. Conductors.

a) Conductors shall meet requirements of Section 26 05 19 Building Wire and Cable. Minimum size to be #12 THWN.

b) Bends in excess of 90 degrees in any grounding conductor shall not be permitted. A radius of 6 inches or greater shall be maintained on all bends.

c) Do not bundle unprotected conductors with protected conductors.

d) Conductors shall be kept as short as possible.

e) Conductors shall be secured at 12" intervals with an accepted copper clamp.

f) Grounding conductors shall be properly connected to the building service ground by accepted clamps.

4. Grounding Connectors

a) Connectors, splicers, and other fittings used to interconnect grounding conductors, bond to equipment or grounding bars, shall be accepted by NEC or UL for the purpose.

b) All connectors and fittings shall be of the Nicopress crimp or compression set screw type.

c) Special treatment to fittings, lugs, or other connectors of dissimilar material shall be applied to prevent electro-galvanic action.

3.15 CONDUIT/BOX IDENTIFICATION

A. Contractor shall identify fire alarm conduit and boxes with red paint in exposed locations. Identify conduit in concealed locations with 4" mark of red paint every 4'-0" OC.

3.16 DEMONSTRATION

A. When system is complete it shall be demonstrated to Owner's Representative who shall be given complete instructions, spare parts, manuals and maintenance information.

3.17 SYSTEM TESTING

A. Prior to certification of the fire alarm system the contractor shall accomplish a complete test of the fire alarm system in accordance with NFPA 72, Test Methods.

B. Perform a complete, functional, component by component test of the entire fire alarm and detection system. Provide a detailed step by step testing procedure which is unique to this project, reflecting the type of system and the number and location of all components.

C. Perform a sensitivity test of all smoke detectors and duct detectors. Perform a calibration/test of heat sensors.

D. Demonstrate the proper operation of each component as follows:

1. Photoelectric, and duct smoke detectors: activate the detector with a "false smoke" product which has been specifically formulated for testing smoke detection systems.

2. Heat detectors: activate the detector by utilizing the detector check button.

3. Pull Stations: activate the station by operating the station in its normal mode.

4. Audible and Visual Alarms: verify proper operation when the system is put into the alarm mode.

5. Sprinkler Flow Switches: open the sprinkler system's inspection test valve. Verify that the flow switch sends an alarm signal within the allowed time corresponding to the switch's time delay setting.

6. Fire Alarm Panels: functionally check-out and test the panel per the manufacturer's written instructions. Demonstrate the proper operation of each modular component. Demonstrate automatic power change to batteries and back to building power upon a drop in voltage below the voltage threshold as specified by the panel manufacturer.

E. Demonstrate the supervisory function at each device loop circuit, and at all single component wiring runs such as for the sprinkler valve supervisory switches.

3.18 CERTIFICATION

A. After completion of the installation of the system, the licensee shall complete a NFPA Inspection and Testing form. The Inspection and Testing form format shall be as indicated in NFPA 72, Inspection and Testing Form. When an Inspection and Testing form has been completed, legible copies shall be distributed as directed by the Authority Having Jurisdiction.

B. After completion of the installation and testing provide NFPA 72, Record of Completion Form to the Owner.

C. After an installation has been complete, affix a Fire Alarm Tag to the control panel. The Fire Alarm Tag is in addition to the Inspection and Testing form. Protect the Fire Alarm Tag from vandalism by applying pressure sensitive label; do not use a "tie-on" tag. It shall be as required in the Fire Safety Rules.

3.19 FINAL DRAWINGS

A. As-built drawings shall be given to the Owner’s representative, at time of instruction, in addition to those to be supplied as general requirements of the job.

3.20 AUTHORITY HAVING JURISDICTION

A. The drawings and specifications herein comply to the best of the Engineer's knowledge with all applicable codes at time of design. However, it is this Contractor's responsibility to coordinate/verify (prior to bid) the requirements of the Authority Having Jurisdiction over this project and bring any discrepancies to the Engineer's attention at least seven days prior to bid. No changes in contract cost will be acceptable after the bid for work/equipment required to comply with the Authority Having Jurisdiction.

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Division 31

Earthwork

SECTION 31 21 10 - SITE CLEARING

PART 1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. Extent of site clearing is shown on drawings.

B. Site clearing work includes, but is not limited to:
1. Protection of existing trees.
2. Removal of trees and other vegetation.
3. Topsoil stripping.
4. Clearing and grubbing.
5. Removing above-grade improvements.
6. Removing below-grade improvements: disconnect and cap utility services.

1.3 JOB CONDITIONS

A. Traffic: Conduct site clearing operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks or other occupied or used facilities without permission from authorities having jurisdiction.

B. Protection of Existing Improvements: Provide protections necessary to prevent damage to existing improvements indicated to remain in place.
1. Protect improvements on adjoining properties and on Owner's property.
2. Restore damaged improvements to their original condition, as acceptable to parties having jurisdiction.

C. Protection of Existing Trees and Vegetation: Protect existing trees and other vegetation indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary guards to protect trees and vegetation to be left standing.
1. Water trees and other vegetation to remain within limits of the contract work as required to maintain their health during course of construction operations.
2. Provide protection for roots over 1-1/2 inches in diameter cut during construction operations. Coat cut faces with an emulsified asphalt, or other acceptable coating, formulated for use on damaged plant tissues. Temporarily cover exposed roots with wet burlap to prevent roots from drying out; cover with earth as soon as possible.
3. Repair or replace trees and vegetation indicated to remain which are damaged by construction operations, in a manner acceptable to Engineer. Employ licensed arborist to repair damages to trees and shrubs.
4. Replace trees which cannot be repaired and restored to full- growth status, as determined by arborist.

D. Improvements on Adjoining Property: Authority for performing removal and alteration work on property adjoining Owner's property will be obtained by Owner prior to award of contract.
1. Extent of work on adjacent property is indicated on Drawings.

E. Salvable Improvements: Carefully remove items indicated to be salvaged, and store on Owner's premises where indicated or directed.

PART 2. PRODUCTS (Not applicable.)

PART 3. EXECUTION

3.1 SITE CLEARING

A. General: Remove trees, shrubs, grass and other vegetation, improvements, or obstructions interfering with installation of new construction. Remove such items elsewhere on site or premises as specifically indicated. Removal includes digging out stumps and roots.
1. Carefully and cleanly cut roots and branches of trees indicated to be left standing, where such roots and branches obstruct new construction.

B. Topsoil: Topsoil is defined as surface soil found in a depth of not less than 4 inches. Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over 2 inches in diameter, and without weeds, roots, and other objectionable material.
1. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material.
   a. Remove heavy growths of grass from areas before stripping.
   b. Where trees are indicated to be left standing, stop topsoil stripping a sufficient distance to prevent damage to main root system.
2. Stockpile topsoil in storage piles in areas shown, or where directed. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent wind-blown dust.
3. Dispose of unsuitable or excess topsoil same as waste material, herein specified.

C. Clearing and Grubbing: Clear site of trees, shrubs and other vegetation, except for those indicated to be left standing.
1. Completely remove stumps, roots, and other debris protruding through ground surface.
2. Use only hand methods for grubbing inside drip line of trees indicated to be left standing.
3. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.
   a. Place fill material in horizontal layers not exceeding 6" loose depth, and thoroughly compact to a density equal to adjacent original ground.

D. Removal of Improvements: Remove existing above-grade and below- grade improvements necessary to permit construction, and other work as indicated.
1. Abandonment or removal of certain underground pipe or conduits may be shown on mechanical or electrical drawings, and is included under work of those sections. Removal of abandoned underground piping or conduit interfering with construction is included under this section.
2. Contact local utility companies 48 hours minimum prior to start of demolition work. Confirm verbal and written notices. Verify locations of all utilities entering site and their location on the site.
3. Cooperate with owner, utility companies, adjacent property owners, and other building trades in maintaining, protecting, rerouting or extending of utilities passing through work areas which serve structures located on project site and on adjacent properties.
4. Verify which utilities are to be removed, capped or abandoned are turned off, or are disconnected, or are rerouted to new locations before starting demolition.

3.2 DISPOSAL OF WASTE MATERIALS

A. Burning on Owner's Property: Burning may be allowed on property with prior approval and permitting from authority having jurisdiction. All burning shall be conducted in a manner to minimize smoke and odor.

B. Removal from Owner's Property: Remove waste materials and unsuitable, excess topsoil off site in legal manner.

END OF SECTION

SECTION 31 22 00 - EARTHWORK

PART 1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to work of this Section.

1.2 SUMMARY

A. This Section includes the following:
1. Preparing of subgrade for building slabs, walks, and structures.
2. For preparation of pavement subgrade.
3. For pavement subgrade stabilization and base, refer to other Division 31 sections.

B. Excavating and Backfilling of Utility Trenches: Refer to Earthwork - Underground Utilities, Section 31 22 10.

C. Final Grading, together with placement and preparation of topsoil for lawns and planting, is specified in Division 31 Section, "Landscape Work."

1.3 DEFINITIONS

A. Excavation consists of removal of material encountered to subgrade elevations indicated and subsequent disposal of materials removed.

B. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be at Contractor's expense.
1. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, when acceptable to Engineer.
2. In locations other than those above, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Engineer.

C. Additional Excavation: When excavation has reached required subgrade elevations, notify Engineer, who will make an inspection of conditions. If Engineer determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as directed by Engineer. The Contract Sum may be adjusted by an appropriate Contract Modification.
1. Removal of unsuitable material and its replacement as directed will be paid on basis of Conditions of the Contract relative to changes in work.

D. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular subbase, drainage fill, or topsoil materials.

E. Structure: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.

1.4 SUBMITTALS

A. Test Reports: Submit the following reports directly to Engineer from the testing services, with copy to Contractor:
1. Test reports on borrow and imported material.
2. Verification of suitability of each footing subgrade material, in accordance with specified requirements.
3. Field reports; in-place soil density tests.
4. One optimum moisture-maximum density curve for each type of soil encountered.
5. Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

B. Testing and Inspection Service: Owner will employ and pay for a qualified independent geotechnical testing laboratory to perform soil testing and inspection service during earthwork operations.

C. Testing Laboratory Qualifications: To qualify for acceptance, the geotechnical testing laboratory must demonstrate to Engineer's satisfaction, based on evaluation of laboratory-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct required field and laboratory geotechnical testing without delaying the progress of the Work.

1.6 PROJECT CONDITIONS

A. Site Information: Data in subsurface investigation reports was used for the basis of the design and are provided at the end of this specification section to the Contractor for information only. Conditions are not intended as representations or warranties of accuracy or continuity between soil borings. The Owner will not be responsible for interpretations or conclusions drawn from this data by Contractor. The geotechnical report is attached herein for reference at end of this section.
1. Additional test borings and other exploratory operations may be performed by Contractor, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.

2. Contractor must adhere to procedures and recommendation outlined in the geotechnical investigation and must follow testing procedures as outlined.

B. Existing Utilities: Locate existing underground utilities in areas of excavation work. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.

1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
   a. Provide minimum of 48-hour notice to Engineer, and receive written notice to proceed before interrupting any utility.
2. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies and Owner for shutoff of services if lines are active.

C. Use of Explosives: Use of explosives is not permitted.

D. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.

1. Operate warning lights as recommended by authorities having jurisdiction.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
3. Perform excavation by hand within dripline of large trees to remain. Protect root systems from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with moistened burlap.

PART 2. PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP.

B. Unsatisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT.

C. Backfill and Fill Materials: Satisfactory soil materials free of clay, rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter. Fill material shall consist of sands with less than 6 percent soil fines passing No. 200 sieve.

PART 3. EXECUTION

3.1 EXCAVATION

A. Excavation is unclassified and includes excavation to subgrade elevations indicated, regardless of character of materials and obstructions encountered.

3.2 STABILITY OF EXCAVATIONS

A. General: Comply with local codes, ordinances, and requirements of agencies having jurisdiction.

B. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

C. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.

3.3 DEWATERING

A. Control of groundwater is required to achieve the necessary construction including earthwork, excavation, backfilling, placement of foundation and utilities. Contractor shall review the subsurface soil exploration provided for requirements of separation between bottom of any excavation or compaction surface and encountered groundwater table.

B. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
   1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
   2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rainwater and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.

3.4 STORAGE OF EXCAVATED MATERIALS

C. Stockpile excavated materials acceptable for backfill and fill where directed. Place, grade, and shape stockpiles for proper drainage.
   1. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.
   2. Dispose of excess excavated soil material and materials not acceptable for use as backfill or fill.

3.5 EXCAVATION FOR STRUCTURES

A. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection.
   1. Excavations for footings and foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. 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 Structures: Conform to elevations and dimensions indicated within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection. Do not disturb bottom of excavations, intended for bearing surface.

3.6 EXCAVATION FOR PAVEMENTS

A. Cut surface under pavements to comply with cross-sections, elevations and grades as indicated.

3.7 TRENCH EXCAVATION FOR PIPES AND CONDUIT

A. Refer to Earthwork - Underground Utilities, Section 31 22 10.

3.8 COLD WEATHER PROTECTION

A. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

3.9 BACKFILL AND FILL

A. General: Place soil material in layers to required subgrade elevations, for each area classification listed below, using materials specified in Part 2 of this Section.
   1. Under grassed areas, use satisfactory excavated or borrow material.
   2. Under walks and pavements, use subbase material, satisfactory excavated or borrow material, or a combination.
   3. Under steps, use satisfactory excavated or borrow material.
   4. Under building slabs, use satisfactory excavated or borrow material.
   5. Under sport fields and a minimum distance of 20 feet beyond the sport field limits use satisfactory fill material with maximum 3% to 5% fines in accordance with geotechnical investigation.
   6. Under playgrounds and exercise area and extending 10 feet beyond use satisfactory fill material with maximum 5% fines.
   7. Backfill trenches with concrete where trench excavations pass within 18 inches of column or wall footings and that are carried below bottom of such footings or that pass under wall footings. Place concrete to level of bottom of adjacent footing.
      a. Concrete is specified in Division 3.

b. Do not backfill trenches until tests and inspections have been made and backfilling is authorized by Engineer. Use care in backfilling to avoid damage or displacement of pipe systems.

8. Provide 4-inch-thick concrete base slab support for piping or conduit less than 2'-6" below surface of roadways. After installation and testing of piping or conduit, provide minimum 4-inch-thick encasement (sides and top) of concrete prior to backfilling or placement of roadway subbase.

B. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
2. Inspection, testing, approval, and recording locations of underground utilities have been performed and recorded.
3. Removal of concrete formwork.
4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.
5. Removal of trash and debris from excavation.
6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

3.10 PLACEMENT AND COMPACTION

A. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

1. When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.

B. Place backfill and fill 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.

C. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

D. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.

E. Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts as directed by Engineer if soil density tests indicate inadequate compaction.

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density, in accordance with ASTM D 1557:
   a. Under structures, building slabs and steps, and pavements, compact top 12 inches of subgrade and each layer of backfill or fill material at 98 percent maximum density.
   b. Under lawn or unpaved areas, compact top 6 inches of subgrade and each layer of backfill or fill material at 90 percent maximum density.
   c. Under walkways, compact top 6 inches of subgrade and each layer of backfill or fill material at 95 percent maximum density.
2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.
   a. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
   b. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.

3.11 GRADING

A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes and as follows:

1. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10 foot above or below required subgrade elevations.
2. Walks: Shape surface of areas under walks to line, grade, and cross-section, with finish surface not more than 0.10 foot above or below required subgrade elevation.
3. Pavements: Shape surface of areas under pavement to line, grade, and cross-section, with finish surface not more than 1/2 inch above or below required subgrade elevation.

C. Grading Surface of Fill under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2 inch when tested with a 10-foot straightedge.

D. Refer to construction drawings for additional requirements for grading of ballfields.

E. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

3.12 PAVEMENT SUBBASE COURSE

A. Refer to other Division 2 sections for preparation of subgrade, subbase, base, and paving specifications.

B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of subbase course.

3.13 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction: Allow testing service to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.
   1. Perform field density tests in accordance with ASTM D 1556 (sand cone method) or AASHTO T-180 or ASTM D 2167 (rubber balloon method), as applicable.
      a. Field density tests may also be performed by the nuclear method in accordance with ASTM D 2922, providing that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556. In conjunction with each density calibration check, check the calibration curves furnished with the moisture gages in accordance with ASTM D 3017.
      b. If field tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each different type of material encountered, and at intervals as directed by the Engineer.
   2. Footing Subgrade: For each strata of soil on which footings will be placed, perform at least one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata when acceptable to Engineer.
   3. Building Slab Subgrade: Perform at least one field density test of subgrade for every 2,000 sq. ft. of paved area or building slab, but in no case fewer than three tests. In each compacted fill layer, perform one field density test for every 2,000 sq. ft. of overlaying building slab or paved area, but in no case fewer than three tests.
   4. Foundation Wall Backfill: Perform at least two field density tests at locations and elevations as directed.
   5. Pavement Subgrade: One field density test for each compacted layer per 10,000 sq. ft. of paved area or 250 l.f. of roadways, but no fewer than three tests per paved area.
   6. If in opinion of Engineer, based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, perform additional compaction and testing until specified density is obtained.

3.14 EROSION CONTROL

A. Provide erosion control methods in accordance with requirements of authorities having jurisdiction.

3.15 MAINTENANCE

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.

C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.

D. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.16 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Removal from Owner's Property: Remove waste materials, including unacceptable excavated material, trash, and debris, and dispose of it off Owner's property.

END OF SECTION

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SECTION 31 22 10 - EARTHWORK - UNDERGROUND UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. The work consists of excavating and backfilling all trenches and pits required for the installation of all underground utilities, pipelines, culverts, appurtenant structures and other items called for or reasonably implied in the Drawings to include sheeting and bracing, dewatering, supply and transport of fill materials, and disposal of waste materials. Appurtenant structures include headwalls, manholes, lift stations, box culverts, junction boxes, catch basins, inlets and other items related to underground systems.

PART 2 - MATERIALS

2.1 Bedding Material - CLASS I: ASTM D 2321, except that sizing shall be 1/4 inch to 3/4 inch. (Angular graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.)

2.2 Bedding Material - CLASS II: ASTM D 2321, except that upper size limit shall be 3/4 inch. (Coarse sands and gravels including variously graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Unified Soil Classification System (USCS) soil types GW, GP, SW, and SP are included.

2.3 Bedding Material - CLASS III: ASTM D 2321. (Fine sand and clay gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures, USCS soil types GM, GC, SM, and SC are included.)

2.4 Initial Lift Backfill: Clean earth fill composed of sand, clay and sand, sand and rock, crushed rock, or approved combination. Under no circumstances shall any muck, stumps, roots, brush, trash, rubbish or organic material be used in the backfill. Material may be selected from the excavation, or obtained, if necessary, from an approved borrow pit area. The fragment size listed below shall not be exceeded for the following pipe materials.

A. Pipe Material	Fragment Size (Greatest Dimension - Inches)
Concrete	3
Steel	3
Cast Iron	3
Ductile Iron	3
Corrugated Metal	3
Vitrified Clay	1-1/2
Plastic	1
Asbestos Cement	1/2

2.5 Final Lift Backfill: As described in the above paragraph, Initial Lift Backfill, except that maximum dimension for any stone or pavement fragment shall be 6 inches.

2.6 Sheeting and Bracing: Wood sheeting to be left in place shall be treated with preservatives per FDOT 955.

PART 3 - EXECUTION

3.1 General: Trenches shall be excavated to the alignment and elevations required to install utilities with proper foundations and bedding. Open no more trench in advance of pipe laying than is necessary to expedite the work.

3.2 Sheeting and Bracing: To prevent damage to property, injury to erosion, cave-ins, of excessive trench widths, or as required by law, adequate sheeting and bracing shall be provided. Sheeting shall be removed when the trench has been backfilled to at least one-half its depth, or when removal would not endanger the construction of adjacent structures. When required, to eliminate excessive trench width or other damage, sheeting, bracing or shoring shall be left in place and the top cut off at an elevation 2.5' below finished grade, unless otherwise specified. Wood sheeting shall not be removed from the trench region below the crown of the pipe.

3.3 Trench Width: The minimum width of the trench shall be equal to the outside diameter of the pipe at the joint plus 8 inches for unsheeted trench, or 12 inches for sheeted trench. Trench walls shall be maintained as vertical as possible to the top of the pipes; the maximum width of trench measured at the top of the pipe shall not exceed the outside pipe diameter plus 2', unless otherwise called for in the Drawings.

3.4 Unstable Trench/Pit Bottom: Where muck or other deleterious materials are encountered at or below trench grade, they shall be removed and replaced with Bedding Material in layers not to exceed 6 inches in thickness, compacted to at least 95% of maximum (AASHTO T-180) density. The Engineer may elect, depending upon the severity of the unstable soil, to require special foundations.

3.5 Over-Excavation: Should the trench be inadvertently over-excavated below a point 6 inches below the bottom of the pipe, but not beyond a point 12 inches below the bottom of the pipe, fill that area of over-excavation with Bedding Material and compact to 95% of maximum (AASHTO T-180) density. Contractor shall fill any area of over-excavation beyond a point 12 inches below the bottom of the pipe with Class I Bedding material to form an impervious mat at his expense. Where the Engineer approves alternate material, compaction shall be not less than 95% of maximum (AASHTO T-180) density.

3.6 Noncushioned Trench Bottom: Where pipe is to be laid in a rock-cut or other noncushioned material, excavation shall allow for 6 inches of bedding beneath the pipe.

3.7 Excavated Materials: Ownership of all suitable excavated materials shall remain with the Owner until the final job requirement for fill or backfill materials have been fulfilled. Unless otherwise provided, any surplus materials then remaining and not needed for job requirements shall become the property of Contractor and are to be disposed of by him. Excavated material to be used for backfill shall be neatly and safely deposited at the sides of the trench/pit where space is available. All excavated material shall be stockpiled in a manner that will not endanger the work. Hydrants under pressure, water and gas valves, manhole covers, fire and police call boxes, or other utility controls shall be left unobstructed and accessible. Gutters shall be kept open or other satisfactory provisions made for street drainage, and natural water courses shall not be obstructed. Unless otherwise approved, stockpiles shall not obstruct adjacent streets, walks or driveways. Temporary store of apparent excess suitable materials in areas provided by Owner until such materials are needed in the job or are declared surplus. With the written approval of the Engineer, Contractor may dispose of such apparent excess material with the stipulation that he shall replace any portion of the disposed material required to fulfill the actual job requirements, with equally suitable material, at his own expense.

3.8 Dewatering: All utilities and structures shall be laid/placed, "in the dry". Dewatering shall be by well-point unless otherwise approved by the Engineer. Dewatering shall be in accordance with good standard practice and all applicable codes and regulations and must be efficient enough to lower the water level in advance of the excavation and maintain the trench or pit bottom and sides continuously firm and dry through inspection. Discharge from dewatering shall not interfere with the normal drainage of the area in which the work is being performed, create a public nuisance or form ponding.

3.9 Bedding: All pipe shall be bedded Class B except where Class A is called for by the Engineer. Bedding shall be in accordance with the Standard Detail Drawings and as described herein.

A. Class B: Raise trench to above pipe grade by placement and compaction of 4 inches to 6 inches of the bedding material specified for the particular system of installation. Provide bell holes to allow continuous support along the pipe barrel. Place and compact maximum (AASHTO T-180) density to the spring line of the pipe. Where coarse materials with voids have been used for bedding, the same coarse material shall also be used for the zone up to the spring line. Avoid vertical and lateral displacement of the pipe from proper alignment.

3.10 Backfill-Initial Lift: Initial Lift Backfill Material, as referenced in the "Initial Lift Backfill" paragraph above, shall be carefully placed and tamped over the upper half of the utility, and shall be carefully continued in layers not exceeding 6 inches in thickness for the full trench width, until the fill is 12 inches above the utility. Available material from the excavation shall be used if approved. The "Initial Lift" shall be thoroughly compacted and completed before the "Final Lift" is placed. Compact to 95% of maximum (AASHTO T-180) density.

3.11 Backfill-Final Lift: The remainder of the trench shall be backfilled with Final Lift Backfill material, as referenced in the "Final Lift Backfill" paragraph above, in layers not exceeding 12 inches. When trenches are cut in pavements or areas to be paved, compaction shall equal 98% of maximum (AASHTO T-180) density. Otherwise, compact to 95%.

3.12 Borrow: Should there be insufficient satisfactory material from the excavation to meet the requirements for fill material, and where borrow sites are not provided in the Contract Documents, borrow sites shall be secured by Contractor.

3.13 Compaction Method: The above specified compaction shall be accomplished using accepted standard methods (powered tampers, vibrators, etc.), with the exception that the first two feet of backfilling over the pipe shall be compacted by manual tamping devices. Flooding or puddling with water to consolidate backfill is not acceptable, except where sand is encountered.

3.14 Material Disposal: Excess, unsuitable, or cleared and grubbed material, resulting from the utility installation, shall be immediately removed from the work site and disposed of. Excess excavated material shall be spread on the disposal site and graded in a manner to drain properly and not disturb existing drainage conditions. Where disposal areas are not provided in the Contract Documents, Contractor shall furnish the disposal area without additional compensation.

3.15 Testing: Provide density testing by a qualified independent laboratory at intervals not to exceed 250 feet.

END OF SECTION

SECTION 31 22 70 - EROSION AND SEDIMENTATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. All erosion, sedimentation and water pollution control features shall be in place or relocated as designated on the plans prior to the start of any clearing, grubbing, grading or construction. Contractor shall be responsible for the installation and maintenance of all temporary erosion control features.

B. Location of the control features shall be in accordance with the Drawings or as required to facilitate drainage and control erosion and sedimentation within and adjacent to the site.

C. Control features are defined as, but not limited to, swales, berms, silt fences, silt barriers and temporary fences.

1.2 QUALITY ASSURANCE

A. The provision for prevention, control and abatement of erosion, sedimentation and water pollution shall be as stated in the Florida Department of Transportation Standard Specifications for Road and Bridge Construction, Section 104, latest edition.

1.3 SUBMITTALS

A. Product data: Manufacturers literature, application instructions and samples.

B. List of materials and their characteristics for other erosion control items.

1.4 CONTROL OF CONTRACTOR'S OPERATIONS WHICH MAY RESULT IN WATER POLLUTION

A. Take sufficient precautions to prevent pollution of streams, canals, lakes, reservoirs, wetlands and other sensitive areas with silt, sediment, fuels, oils, bitumens, calcium chloride, or other harmful materials. Conduct and schedule operations so as to avoid or otherwise minimize pollution or siltation of such streams, etc. and to avoid interference with movement of migratory fish. Do not dump the residue from dust collectors or washers into any water body.

B. Construction operations in rivers, streams, lakes, tidal waters, reservoirs, canals, and other impoundments shall be restricted to those areas where it is necessary to perform filling or excavation to accomplish the work shown in the Contract Documents and to those areas which must be entered to construct temporary or permanent structures. As soon as conditions permit, promptly clear rivers, streams, and impoundments of all obstructions placed therein or caused by construction operations.

C. Except as necessary for construction, do not deposit excavated material in rivers, streams, canals, or impoundments, or in a position close enough thereto, to be washed away by high water or run-off.

D. Where pumps are used to remove highly turbid waters from enclosed construction areas such as cofferdams or forms, treat the water prior to discharge into State waters. Pump the water into grassed swales, appropriately vegetated areas, or sediment basins, or confine it by an appropriate enclosure such as siltation curtains when other methods are not considered appropriate. Do not contaminate State waters. The background condition of all waters to be discharged from the site must be tested prior to discharge. All waters discharged from the site must be approved through Orange County Environmental Department by the Engineer.

E. Do not disturb lands or waters outside the limits of construction, unless approved in advance and in writing by the Owner. No operations within non-permitted wetlands or upland buffers are allowed.

1.5 START OF WORK

A. Do not start work until erosion control measures are in place.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Silt Barriers:
1. Two types of silt barriers shall be installed in accordance with the plans: silt barriers installed on the ground and floating silt barriers.
2. Silt barriers (filter fabric) shall be synthetic and contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six (6) months of expected usable construction life at a temperature range of 0 to 120□F.
3. Filter fabric shall be a pervious sheet of propylene, nylon or polyester and shall be certified by the manufacturer or supplier to conform to the following specifications:
   - Filter efficiency (Test VTM-51): 75%.
   - Minimum tensile strength at 20% elongation (Test ASTM-D-1682): 120 lbs.
   - Tear strength (Test ASTM D2263): 50 lbs.
4. Contractor shall submit further filter fabric material specifications and installation configuration prior to start of construction.
5. Silt barriers shall be maintained in place.
6. Filter fabric shall be purchased in a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are necessary, filter fabric shall be spliced together only at a support post, with a 6 inch overlap, and securely sealed.
7. The following items shall be installed and maintained in accordance with the applicable sections of the FDOT Standard Specifications:
   a. Temporary silt fences and staked silt barriers
   b. Floating silt barrier

B. Temporary Fence
1. Brightly colored fence as manufactured by Mirafi, product Mirasafe, or approved equal.
2. Material shall be 4' high, attached to 6' metal posts at 12' centers. Posts shall be driven 18" into ground.

PART 3 - EXECUTION

3.1 GENERAL

A. Temporary erosion control features shall consist of, but not be limited to, temporary grassing, temporary sodding, temporary mulching, sandbagging, slope drains, sediment basins, artificial coverings, berms, baled hay or straw, floating silt barriers, staked silt barriers and staked silt fences. Design details for some of these items may be found in the Water Quality Section of the applicable edition of the FDOT Roadway and Traffic Design Standards. All of these items shall be constructed in accordance with applicable sections of the FDOT Standard Specifications.

B. Incorporate permanent erosion control features into the project at the earliest practical time. Correct conditions, using temporary measures, that develop during construction to control erosion prior to the time it is practical to construct permanent control features.

C. Construct temporary and permanent erosion and sediment control measures and maintain them to prevent the pollution of adjacent water ways in conformance with the laws, rules and regulations of Federal, State and local agencies.

D. Copies of approved permits will be provided to the Contractor for his review and use. Contractor shall be required to comply with all General and Special Conditions noted within the permit by the particular permitting agency. The Contractor shall maintain copies of these permits on the job site at all times.

3.2 INSTALLATION

The following items shall be installed in accordance with the FDOT Standard Specification. The procedures are only generally described herein.

A. Temporary Grassing: This work shall consist of furnishing and placing grass seed.

B. Temporary Sod: This work shall consist of furnishing and placing sod.

C. Temporary Mulching: This work shall consist of furnishing and applying a two-inch to four-inch thick blanket of straw or hay mulch and then mixing or forcing the mulch into the top two inches of the soil in order to temporarily control erosion. Only undecayed straw or hay, which can readily be cut into the soil, shall be used. Other measures for temporary erosion control such as hydro-mulching, chemical adhesive soils stabilizers, etc., may be substituted for mulching with straw or hay with the approval of the Owner. When permanent grassing operations begin, temporary mulch materials shall be plowed under in conjunction with preparation of the ground.

D. Sandbagging: This work shall consist of furnishing and placing sandbags in configurations, so as to control erosion and siltation.

E. Slope Drains: This work shall consist of constructing slope drains, utilizing pipe, fiber mats, rubble, cement concrete, asphaltic concrete plastic sheeting, or other acceptable materials, in accordance with the details shown in FDOT's Roadway and Traffic Design Standards or as may be approved as suitable to adequately perform the intended function.

F. Sediment Basins: Sediment basins shall be constructed in accordance with the details shown in FDOT's Roadway and Traffic Design Standards or as suitable to adequately perform the intended function. Sediment basins shall be cleaned out as necessary.

G. Artificial Coverings: This work shall consist of furnishing and applying fiber mats, netting, plastic sheeting, or other approved covering to the earth surfaces.

H. Berms: This work shall consist of construction of temporary earth berms to divert the flow of water from an erodible surface.

1. This work shall consist of construction of baled hay or straw dams or earth berms to protect against downstream accumulations of silt. The baled hay or straw dams shall be constructed in accordance with the details shown in FDOT's Roadway and Traffic Design Standards.
2. The berm or dam shall be placed so as to effectively control silt dispersion under conditions present on this project. Alternate solutions and usage of materials may be used if approved.

3.3 SILT BARRIERS

A. Silt barriers shall be installed and maintained at the locations shown on the plans. The Contractor is required to prevent the possibility of silting onto any adjacent parcel.

B. Silt barrier shall be of the staked type and stakes shall be installed as indicated in the drawings.

C. The height of the silt barrier fabric shall be a minimum of 42 inches.

D. The stakes shall be 2 inch x 4 inch wood, 5 feet long and shall be spaced a maximum of 10 feet apart at the barrier location and driven securely into the ground.

E. A trench shall be excavated approximately 4 inches wide by 4 inches deep along the line of stakes. The filter fabric shall be tied or stapled to the wooden stakes and 8 inches of fabric shall be extended into the trench. The staples shall be heavy duty wire and at least one-half (1/2) inch long. The trench shall then be backfilled and the soil compacted over the filter fabric.

3.4 FLOATING SILT BARRIERS

A. Floating silt barriers where required shall be in place prior to the start of any construction or grading.

B. Floating silt barriers shall meet or exceed the Florida Department of Transportation Roadway and Traffic Design Standards, Index No. 102, Floating Silt Barrier. Contractor shall submit fabric filter material specifications and installation configuration for approval prior to the start of construction.

3.5 TEMPORARY FENCE

A. Furnish, install and maintain on wetland lines, buffer lines, tree save lines and otherwise as shown on plans. Attach silt barrier to the temporary fence.

B. Follow manufacturer's installation recommendations.

3.6 MAINTENANCE

A. Silt barriers and temporary fences shall be inspected immediately after each rainfall and at least once a day during periods of prolonged rainfall. Any repairs shall be made immediately.

B. Should the fabric on a silt barrier or temporary fence decompose or become ineffective, the installation shall be repaired or replaced immediately at no additional cost to the Owner. If the Contractor fails to repair or replace the items as above, the Owner shall have the right to stop work without additional cost to the Owner until such time as the repair or replacement has been made.

C. Sediment deposits shall be removed after each storm event. The Contractor will repair and restore the installations to a working and effective condition to the satisfaction of the Owner.

D. At the completion of all work, the silt barriers and the temporary fences will be removed if by the Owner.

E. Any sediment deposits in place after the silt fence or filter barrier is no longer required shall be dressed to conform to the existing grade and prepared for seeding or sodding.

3.7 PROTECTION DURING SUSPENSION OF CONTRACT TIME

A. In the event that it is necessary that the construction operations be suspended for any appreciable length of time, shape the top of the earthwork in such a manner as to permit run-off of rainwater and construct earth berms along the top edges of embankments to intercept run-off water. Provide temporary slope drains to carry run-off from cuts and embankments which are located in the vicinity of rivers, streams, canals, lakes and impoundments. Should such preventative measures fail, immediately take such other action as necessary to effectively prevent erosion and siltation.

END OF SECTION

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SECTION 31 25 10 - SUBGRADE STABILIZATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. Stabilize the designated portions of the pavement subgrade in both cut and fill sections to provide a firm and unyielding subgrade to the uniformity, density, bearing value, lines, grades and thicknesses herein specified or shown in the Drawings. The work includes mixing, compacting and grading for a complete job.

PART 2 - MATERIALS

2.1 Local Materials: High bearing-soils or sand clay material. The materials passing the #40 mesh sieve shall have a liquid limit not greater than 30, and a plasticity index not greater than 10. Blending materials to meet these requirements will not be permitted unless authorized by the Engineer. When so permitted, the blended material shall be tested and approved before spreading.

2.2 Limerock/Limerock Overburden: The percentage of carbonates of Calcium and magnesium shall be at least 70, and plasticity index shall not exceed 10. The gradation shall be such that 97% be weight of the material will pass a 1" sieve.

2.3 Crushed Shell: Mollusk shell, but not steamed shell, (i.e., oysters, mussels, clams, cemented coquina, etc.). Gradation shall be such that at least 97% by weight of the total material passes a 1" sieve, and at least 50% by weight is retained on the #4 sieve. Not more than 20% by weight of the total material shall pass (by washing) the #200 sieve.

PART 3 - EXECUTION

3.1 Required Florida Bearing Value (FBV): Unless otherwise specified, the subgrade shall have a minimum Florida Bearing Value of 70. Where local material does not conform to the required FBV, stabilize by uniformly mixing with satisfactory local or hauled in material to the depth shown in the Drawings. Perform bearing valve determination per FDOT standard specifications for Road and Bridge Construction, section 160-8.1.

3.2 Compaction: Compact the stabilized subgrade in both cuts and fills to a minimum density of 98% of maximum (AASHTO T-180) density. The subgrade shall be shaped to within 1/4 inch of the grades shown in the Drawings.

3.3 Maintenance: After the subgrade has been prepared as specified, Contractor shall maintain it free from ruts, depressions and all damage resulting from hauling or handling of any materials, equipment, tools, etc. All work which may become necessary in order to recompact the subgrade shall be at contractor's expense.

3.4 Testing: Provide density and bearing value tests at intervals not to exceed 250 feet for roadways or 10,000 square feet for parking areas.

END OF SECTION

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SECTION 31 25 11 - SOIL CEMENT

PART 1.00 - GENERAL

1.01 SECTION INCLUDES

A. Soil-cement surfacing.

1.02 QUALITY ASSURANCE

A. Reference specifications and standards:

1. Standard Specifications for Road and Bridge Construction, latest edition, issued by Florida Department of Transportation, specified hereinafter as FDOT.

a. Statements in this Specifications Section take precedence over FDOT Standards if there are ambiguities.

b. Where paragraphs of the FDOT Standards referenced herein include reference to further paragraphs, the further referenced paragraph(s) are also made a direct part of this Specification.

c. All references to "Department," “Engineer,” or “District Materials Engineer” in referenced standard shall be construed to mean "Owner" for this Work.

d. Method of measurement and method of payment for all Work shall be construed to mean lump sum basis, in accord with terms of Contract.

e. Reference to Soil-Cement Base in the cited FDOT standard shall be construed to mean soil-cement surfacing work of this Section.

0.01 SUBMITTALS

A. Material Certificates: Provide copies of materials certificates signed by material producer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

PART 2.00 - PRODUCTS

2.01 MATERIALS

A. Soil-cement surfacing: Conform to FDOT Section 270-2 for materials.

B. Exceptions:

1. Emulsified asphalt shall not be used for curing. Do not use any curing medium other than the natural environment. Expected slight cracking will not be a problem.

2. Color of resulting soil mix shall closely match the color of the soils of the ride path.

2.02 STRENGTH DESIGN

A. Conform to FDOT Section 270-3.2. Resulting strength of design mix shall be not less than 500 psi.

PART 3.00 - EXECUTION

3.01 SOIL-CEMENT SURFACING

A. Conform to FDOT Section 270-4 for construction methods.

1. Emulsified asphalt and consequential application of sand to aid in drying shall not be used.
2. The soil-cement surfacing for this work is intended to be the finished wearing surface.
3. Asphaltic concrete shall not be used for patching. If patching is required, use the same type soil-cement materials in the work.

END OF SECTION 31 25 11

SECTION 31 25 12 – LIMEROCK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. Construct limerock base course on the prepared subgrade as specified herein and in conformance with the lines and grades shown in the Drawings.

1.3 SUBMITTALS

A. Material Certificates: Provide copies of materials certificates signed by material producer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

PART 2 - MATERIALS

2.1 Limerock: FDOT 200-2.

PART 3 - EXECUTION

3.1 Spreading: Uniformly spread limerock by mechanical rock spreader, equipped with a device which strikes off uniformly to laying thickness, and is capable of even distribution. Where a mechanical spreader is not practical such as crossovers, intersections and ramp areas; roadway widths of 20 feet or less; and main roadway areas when forms are used, spreading may be done by bulldozers or blade graders. Remove and replace all segregated areas of fine or course rock with properly graded rock.

3.2 Transportation: Transport limerock to the point of use over rock previously placed, and dump on the end of the preceding spread. Hauling over the subgrade and dumping on the subgrade will not be permitted.

3.3 Courses: Construct bases of specified compacted thickness greater than 6 inches in two courses. The thickness of the first course shall be approximately one-half the total thickness of the finished base, or enough additional to bear the weight of the construction equipment without disturbing the subgrade.

3.4 Compacting and Finishing: Clean the lower course (where applicable) of foreign material, blade the surface to a cross-section approximately parallel to the finished base. The lower course shall be tested for density prior to spreading the upper course. After the upper course has been spread, scarify and shape the surface to produce the required grade and cross-section after compaction, free of scabs and laminations.

3.5 Moisture Content: Material not having the proper moisture content to insure the required density, shall be wetted or dried as required. Mix-in added water uniformly by disking to the full depth of the course. Wetting and drying operations require manipulation, as a unit, of the entire width and depth of the course which is to be compacted.

3.6 Density Requirements: After attaining proper moisture conditions, compact to a density of not less than 98 percent of maximum (AASHTO T-180) density.

3.7 Correction of Defects - If, at any time, the subgrade material should become mixed with the base course material, the Contractor shall, without additional compensation, dig out and remove the mixture, reshape and compact the subgrade and replace the materials removed with clean base material, which shall be shaped and compacted as cited herein.

Cracks or checks appearing in the base, either before or after priming, which would impair the structural efficiency of the base, shall be removed by rescarifying, reshaping, adding base material, recompacting and repriming without additional compensation.

3.8 Priming and Maintaining: Apply the prime coat only when the base meets the specified density requirements, and the moisture content in the top half of the base does not exceed 90 percent of the optimum moisture of the base material. At the time of priming, the base shall be firm, unyielding and in such condition that no undue distortion will occur.

Maintain the true crown and template, with no rutting or other distortion, and insure that the base meets all requirements at the time the surface course is applied.

3.9 Surface Requirement: Irregularities greater than 1/4 inch, when checked with a template cut to the required crown and with a 15-foot straightedge laid parallel to the center of the roadway, shall be corrected by scarifying and removing or adding rock as required and recompacting the entire area as specified.

3.10 Thickness Requirement: Where the base is deficient by more than 1/2 inch, it shall be reworked to the area extent specified by the testing laboratory and to a depth of at least 3 inches by scarifying and adding more base material, so that after proper compaction the thickness will conform to the Drawings.

3.11 Testing Density: Provide three density determinations on each day's final compaction operation on each course. Blading to grade where required shall be completed prior to density testing.

A. Surface: Check the finish surface of the base course with a template cut to the required crown and with a 15-foot straight edge laid parallel to the center of the roadway.

3.12 Thickness: Provide test holes at intervals not to exceed 250 feet for roadways or 10,000 square feet for parking areas.

END OF SECTION

SECTION 31 25 13 - ASPHALT CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. Extent of asphalt concrete paving work is shown on drawings.

B. Prepared aggregate subbase and base is specified in "SUBGRADE STABILIZATION," "LIMEROCK" and "SOIL CEMENT" Sections.

C. Prepared subgrade is specified in "EARTHWORK" Section.

D. Saw-cutting of edges of existing pavement is specified in site clearing section.

1.3 SUBMITTALS

A. Material Certificates: Provide copies of materials certificates signed by material producer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

1.4 QUALITY ASSURANCE

A. Codes and Standards: Comply with State highway or transportation department standard specifications, latest edition, and with local governing regulations if more stringent than herein specified.

PART 2 - PRODUCTS

2.1 MATERIALS

General: Use locally available materials and gradations which exhibit a satisfactory record of previous installations.

A. Type S Asphaltic Concrete: FDOT, 331-2, 3, 4, 5.

B. Type III Cement Asphaltic Concrete: FDOT, 333-2, 3, 4 and 5.

C. Asphalt Cement: FDOT, 916-1

D. Prime Coat: Cut-back asphalt grade RC-70 or RC-250 per FDOT 916-2; emulsified asphalt grade SS-1 or SS1H, per FDOT 916-4, diluted in equal proportions with water; or other types and grades of bituminous material.

E. Tack Coat: Emulsified asphalt; RS-2, SS-1, or SS-1H (diluted in equal proportions with water) per FDOT 916-4. Cut-back asphalt RL-70, or asphalt cement, penetration grade 85-100.

F. Lane Marking Paint: Chlorinated rubber-alkyd type, AASHTO M 248 (FS TT-P-115), Type III or per FDOT 971-12.2.

G. Thermoplastic Traffic Stripes and Markings: Per FDOT standard specifications for Road and Bridge Construction, Section 711.

H. Wheel Stops: Precast of 3,500 psi air-entrained concrete, approximately 6 inches high, and 6 feet 0 inches long, with chamfered corners and drainage slots on underside.

2.2 ASPHALT-AGGREGATE MIXTURE AND PREPARATIONS

A. FDOT 330-5, and FDOT 330-6.

PART 3 - EXECUTION

3.1 WEATHER LIMITATIONS

A. Mixture shall not be spread when the air temperature is not greater than 40° F, in the shade (away from artificial heat), or there is evidence of a frozen base, or when the wind is blowing to such an extent that proper and adequate compaction cannot be maintained or when sand, dust, etc., are being deposited on the surface being paved.

Any mixture caught in transit by a sudden rain may be laid only at Contractor's risk. Should such mixture prove unsatisfactory, it shall be removed and replaced at Contractor's expense. In no case shall the mixture be laid while rain is falling or when there is water on the surface to be covered.

3.2 PREPARATION OF ASPHALT CEMENT

A. Heat the asphalt cement in advance of the mixing operations, to within a range of 270° F to 350° F. Maintain the heating operations constant within these limits. Wide temperature fluctuations during the day will not be permitted.

3.3 PREPARATION OF AGGREGATE

FDOT 330-5

3.4 PREPARATION OF MIXTURE

FDOT 330-6

3.5 TRANSPORTATION OF MIXTURE

Transport the mixture in vehicles clean of foreign material properly equipped to be covered during inclement weather. Coat the inside surfaces of the truck with soapy water or approved emulsion containing less than 5 percent oil (not kerosene, gasoline or similar products) and raise beds to drain excess prior to loading.

3.6 PREPARATION OF APPLICATION SURFACES

A. Cleaning: Thoroughly clean the surface to be covered of all loose and deleterious material before laying any mixture.

B. Patching and Leveling Courses: Where a surface course is constructed on an existing pavement or base and/or where called for in the Drawings, apply patching or leveling courses to bring the existing surface to proper grade and cross-section. Prior to spreading leveling courses, all depressions in the existing surface more than one inch deep shall be filled by spot patching with leveling course mixture, and then thoroughly compacted.

C. Coating Surfaces of Contacting Structures: Paint all structures such as manholes, inlet, valve boxes, etc., with a uniform coating of asphaltic cement.

D. Prime Coat: Prime materials shall be uniformly applied using a pressure distributor at the minimum rates of 0.10 gallons per square yard for limerock, limerock stabilized and local rock bases, and 0.15 gallons per square yard for sand, clay, shell and shell stabilized bases. The actual amount to be applied shall be dependent on the character of the surface and shall be sufficient to coat the surface thoroughly without having any access to form pools or to flow off the base. The temperature of the prime material shall be that temperature between 100^{o} F and 150^{o} F, which will insure uniform distribution. The moisture content of the base shall not be greater than 90 percent of optimum to obtain adequate penetration.

Apply a light uniform application of cover material and roll with a traffic roller for at least 10 passes before opening to traffic. Where an emulsified asphalt is used for prime coat, the Engineer may require that cover material be hot-asphalt coated with two to four percent asphalt-cement, if necessary, to achieve a prime coat which will remain reasonably intact until the surface course is placed; the application rate shall be approximately 10 pounds per square yard.

3.7 TACK COAT

A tack coat will only be required on primed bases in areas that have become excessively dirty and cannot be cleaned, or in areas where the prime has cured to the extent that it has lost adequate bonding effect. Generally, a tack coat will be required on bituminous base or leveling courses before placing the surface course.

Apply tack, suitably heated, at the minimum rate necessary to bond the wearing surface to the base (between 0.02 and 0.08 gallons per square yard). The upper limit may be exceeded for resurfacing concrete. Apply tack sufficiently in advance of the wearing course to permit drying but not so far in advance to allow loss of adhesiveness from dust and other foreign material. No traffic shall be allowed on the tacked surface.

3.8 PLACING MIXTURE

A. Mixture shall be placed and spread only after the surface to be overlayed is properly prepared, intact, firm, properly cured and dried. No mixture shall be spread that cannot be finished and compacted during the daylight hours of day of spreading.

Spread the mixture with mechanical spreaders, except where impracticable. A stringline shall be used to obtain an accurate, uniform alignment of the pavement edge. The temperature of the mixture at the time of spreading shall be between 270° F and 350° F.

1. Checking Depth of Layer: The depth of each layer shall be checked by the Contractor at intervals, not to exceed 25 feet. Any deviation from the required thickness, in excess of the allowable tolerance, shall be immediately corrected.

B. Surface Courses:

1. Spreading and Finishing: Immediately upon arrival, the mixture shall be dumped into the spreader, spread and struck-off to the full width required and to such loose dept to secure the specified thickness. Excess mixture shall be carried ahead of the screed at all times. Hand rake behind the machine as required.
2. Thickness of Layers: Surface courses of thickness greater than two inches, shall be constructed in approximately equal layers and of less than two inches compacted thickness. Each layer shall be thoroughly compacted and shall conform to these specifications prior to overlaying.
3. Correcting Defects: Prior to rolling, the surface shall be checked, and irregularities adjusted. All drippings, fat sandy accumulations from the screed, and fat spots from any source shall be removed and replaced with satisfactory material. No skin patching shall be done. Where a depression is to be corrected while the mixture is hot, the surface shall be well scarified before the addition of fresh mixture.

C. Leveling Courses:

1. Spreading: The initial and intermediate leveling courses shall be placed by a spreader box, working conjunction with two motor graders. The final leveling course shall be placed by a paving machine. However, if the total quantity of leveling to be applied is less than 150 pounds per square yard, the paving machine may not be required.
2. Application Rates: The application rate of leveling mixture shall not exceed 50 pounds per square yard per course except Type S-1 asphaltic concrete leveling shall not exceed 75 pounds per square yard per course. The actual application rate shall be as required to establish the finished lines and grades shown in the Drawings and shall not be limited to any average or typical rate or thickness which may be shown in the Drawings.
3. Leveling Over Existing Concrete Pavement: Remove all excess joint filler to flush with the existing pavement. For broken concrete pavement (with or with out existing asphalt surface) the first leveling course shall be placed as soon after, but not later than 2 days after, the cracking and reseating operation.

3.9 COMPACTING MIXTURE

Density required for asphaltic concrete pavement, after final compaction, shall be as least 95 percent of the laboratory compacted density of the paving mixture. Tests shall be performed every 500 feet for roadways and 50,000 square feet for parking areas.

A. Equipment and Sequence: For each paving or leveling train in operation, the Contractor shall furnish a separate set of rollers, with operators. The rolling shall be done in sequence, and with the equipment as follows, unless otherwise permitted by the Engineer:

1. Seal Rolling - Use tandem steel rollers weighing 5 to 12 tons, following as close behind the spreaders as is possible without pick-up, undue displacement or blistering of the material.
2. Rolling with Traffic Roller - Use self-propelled pneumatic-tied rollers, 6 to 10 tons and tire pressure to 55 pounds, following as close behind the seal rolling as the mix will permit. The roller shall cover every portion of the surface with at least five passes.
3. Final Rolling - Use tandem steel roller, weighing 8 to 12 tons after the pneumatic-tired rolling has been completed, but before the pavement temperature has dropped below 140^{o} F.

B. Compaction of Crossovers, Intersections, etc.: Where a separate paving machine is used to pave crossovers, compaction may be done by one 8 to 10 ton tandem steel roller. If crossovers, intersections and acceleration and deceleration lanes are placed with the main run of paving, a traffic roller shall also be used in the compaction.

C. Rolling Procedures: The rolling shall be longitudinal. Where the lane being placed is adjacent to a previously placed lane, the center joint shall be pinched or rolled, prior to rolling of the rest of the lane. Continue across the mat, overlapping each previous roller path by at least one-half the width of the roller wheel. The motion of the roller shall be slow enough to avoid displacement of the mixture, and any displacement shall be corrected at once by the use of rakes, and the addition of fresh mixture if required. Final rolling shall continue until all roller marks are eliminated.

Self-propelled, pneumatic-tired traffic rollers shall proceed at a speed of 6 to 10 miles per hour; the area covered by each roller shall not exceed 4,000 square yards per hour, except that for Type S-1 Asphaltic Concrete, the maximum shall be 3,000 square yards per hour.

D. Number of Traffic Rollers Required: A sufficient number of self-propelled pneumatic-tired rollers shall be used to assure that the rolling will not delay any other phase of the laying operation nor result in excessive cooling of the mixture. In the event that the rolling falls behind, the laying operation shall be discontinued until the rolling operations are sufficiently caught up.

E. Rolling Patching and Leveling Courses: Use self-propelled pneumatic-tired rollers for all patching and leveling courses. Where the initial leveling course is placed over broken concrete pavement, the pneumatic-tired rollers shall weight at least 15 tons. For Type S-I Asphaltic Concrete leveling courses, use a steel-wheeled roller, to supplement the traffic rollers. The use of a steel-wheeled roller will otherwise be at Contractor's option.

Areas which are inaccessible to a roller (such as areas adjacent to curbs, headers, gutters, manholes, etc.) shall be compacted by the use of hand tamps or other satisfactory means.

F. Correcting Defects: Rollers shall not deposit gasoline, oil or grease onto the pavement. Any areas damaged by such deposits shall be removed and replaced. While rolling is in progress, the surface shall be tested continuously and all discrepancies corrected to comply with the surface requirements. All drippings, fat or lean areas and defective construction of any description shall be removed and replaced. Depressions which develop before the completion of the rolling shall be remedied by loosening the mixture and adding new mixture to bring the depressions to a true surface. Should any depressions remain after the final compaction has been obtained, the full depth of the mixture shall be removed and replaced with sufficient new mixture to form a true and even surface. All high spots, joints and honeycomb shall be corrected. Any mixture remaining unbonded after rolling shall be removed and replaced. Any mixture which becomes loose or broken, mixed or coated with dirt or in any way defective, prior to laying the wearing course shall be removed and replaced with fresh mixture which shall be immediately compacted to conform with the surrounding area. Areas of defective surface may be repaired by the use of the indirect heat. No method of repair involving open-flame heaters shall be used.

G. Provisions Applicable to Shoulder Pavement Only: Where sand-asphaltic shoulders are constructed within the limits of curb and gutter, compaction shall be done by light weight rolling equipment, which will not displace the previously constructed curb and gutter.

3.10 JOINTS

A. Fresh mixture shall be laid against the exposed edges at joints (trimmed or formed as provided below) in close contact with the exposed edge so that an even, well-compacted joint will be produced after rolling.

1. Transverse Joints: Placing of the mixture shall be as continuous as possible. The roller shall not pass over the unprotected end of the freshly laid mixture except when the laying operation is to be discontinued long enough to permit the mixture to become chilled. When the laying operation is thus interrupted, a transverse joint shall be constructed by cutting back on the previous run to expose the full depth of the mat.
2. Longitudinal Joints: Where a portion of the width of pavement is to be laid and opened to traffic, longitudinal joints shall be formed by rolling the exposed edge of the strip first laid. When the adjacent strip is constructed, the Engineer may require the edge of the mixture in place to be trimmed back to expose an unsealed or granular vertical surface. Where the strip first laid is closed to traffic, the edge shall not be sealed but shall be left vertical and the adjacent strip placed against it without trimming.

3.11 SURFACE REQUIREMENTS & CORRECTION:

A. The finished surface shall not vary more than 3/16 inch when measured by rolling or manual straightedge applied parallel to the center line of the pavement. Any surface irregularities exceeding such limits shall be corrected as specified herein.

1. Manual Straightedging: A 15-foot manual straightedge shall be furnished by the Contractor and shall be available at all times on the work. The Contractor shall designate an employee whose duty it is to handle the straightedge in checking the compacted surfaces.
2. Texture of Finished Surfaces: The finished surface shall be of uniform texture and compaction. The surface shall have no pulled, torn or loosened portions, and shall be free of sand streaks, sand spots or ripples. (These requirements shall also apply to any areas where it is necessary to apply hand work.) Defective area shall be corrected as follows:
   a. If the correction is made by replacing of the full thickness, it shall extend to at least 50 feet each side of the defective area.
   b. If the correction is made by overlaying, the overlay shall consist of at least 100 pounds of mixture per square yard at the defective section and shall taper uniformly down from the full thickness of such weight, to zero thickness (featheredged) at the end of a minimum length of 50 feet each side of the defective area.

3.12 PROTECTION OF FINISHED SURFACE

A. Finished surfaces including courses to be overlayed shall be kept clean and no dumping of any material onto the surfaces shall be permitted. Protect pavement against damage during shoulder construction by providing proper attachments to grader blades. Vehicular traffic shall not be permitted until the pavement has set sufficiently to prevent rutting or other distortion.

3.13 TRAFFIC AND LANE MARKINGS

A. Cleaning: Sweep and clean surface to eliminate loose material and dust.

B. Striping: Use chlorinated-rubber base traffic lane-marking paint, factory-mixed, quick-drying, and non-bleeding.

1. Color: white and yellow as indicated on drawings.
   a. Apply paint with mechanical equipment to produce uniform straight edges. Apply in 2 coats at manufacturer's recommended rates.

3.14 WHEEL STOPS

A. Secure wheel stops to asphalt concrete surface with not less than two 3/4 inch diameter steel dowels embedded in precast concrete at 1/3 points. Size length of dowel to penetrate at least 6 inches into asphalt concrete. Drill placement holes oversize and embed dowels in hot bituminous grout material.

3.15 FIELD QUALITY CONTROL

A. THICKNESS REQUIREMENTS & CORRECTIONS

1. Pavement thickness shall be determined from the length of the core borings as specified herein. The maximum allowable deficiency from the specified thickness and serious deficiency thickness shall be as follows:
   a. Pavement of specified thickness 1 1/2 inches or less
      Maximum allowable deficiency 3/16 inch or more
      Serious deficiency 1/4 inch or more
   b. Pavement of specified thickness greater than 1 1/2 inches but less than 2 1/2 inches
      Maximum allowable deficiency 1/4 inch or more
      Serious deficiency 3/8 inch or more
   c. Pavement of specified thickness 2 1/2 inches or greater
      Maximum allowable deficiency 1/2 inch or more
      Serious deficiency 3/4 inch or more
2. Contractor shall correct seriously deficient areas either by replacing the full thickness for a length extending at least 50 feet from each end of the deficient area, or (when permitted by the Engineer) by overlaying as specified herein at his own expense.

   As an exception to the above, pavement outside a main roadway area (acceleration and deceleration lanes, crossovers and parking areas) may be left in place, without compensation (except for payment for the bituminous material), when so permitted by the Engineer, even though the thickness deficiency exceeds the serious deficiency tolerance specified above.

   Where the deficiency exceeds allowable but does not exceed serious, Contractor will be allowed to leave such pavement in place, but without compensation other than for the bituminous material contained therein. The areas of such pavement for which no square yard payment will be made shall be the product of the total distance between acceptable cores, multiplied by the width of the lane which was laid at the particular pass in which deficient thickness was indicated. To determine the extent of the deficiencies, additional cores will be taken as required.
3. Correcting Deficiency by Adding New Surface Material: For any case of excess deficiency of the pavement, Contractor will be permitted, if approved by the Engineer for each particular location, to correct the deficient thickness by adding new surface material and compacting to the same density as the adjacent surface. The area to be corrected and the thickness of the new material added shall be as specified herein. All costs of the overlaying and compacting shall be borne by the Contractor.

B. CALCULATION FOR THICKNESS OF PAVEMENT

1. Core Borings: The thickness of the pavement shall be determined from the length of cores, at least two inches in diameter, taken at random points along the roadway and the parking areas. Each core shall represent a roadway section not longer than 500 feet or a parking area not less than 10,000 square feet. The average thickness shall be determined from the measured thicknesses, and in accordance with the procedure and criteria specified herein.

   If it is found that the specified pavement thickness has not been installed per this specification and if Contractor believes that the number of cores taken by the Owner is insufficient to properly indicate the thickness of the pavement, he may request the owner make additional borings at locations designated by him. The cost of these additional borings shall be deducted from any sums due Contractor unless such borings indicate that the pavement within the questioned area is of specified thickness.

2. Criteria for Calculations:
   a. Average thickness shall be calculated for the total length of project.
   b. When the thickness as measured by the cores is more than 1/2 inch greater than the specified thickness, it shall be considered in the calculation as the specified thickness plus 1/2 inch.
   c. Areas of deficient thickness pavement which are left in place with no compensation shall not be taken into account in the calculations.
   d. Where areas of defective surface or deficient thickness are corrected by overlaying with additional material, the thickness used in the calculations shall be the specified thickness for such areas.

C. TESTING

1. The contractor shall provide, at his expense, the following tests before stating any laying operations:
   a. Determination of the job mix formula
   b. Tests of the asphalt cement
   c. Sieve analysis of the aggregate
   d. Determination of bitumen content of the asphalt concrete

END OF SECTION

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SECTION 31 25 20 - PORTLAND CEMENT CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. Extent of portland cement concrete paving is shown on drawings, including curbs, gutters, walkways and pavement.

B. Prepared subgrade is specified in "EARTHWORK" section.

C. Concrete and related materials are specified in Division-3.

D. Joint fillers and sealers are specified in Division-7.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Comply with local governing regulations if more stringent than herein specified.

1.4 SUBMITTALS

A. Furnish samples, manufacturer's product data, test reports, and materials' certifications as required in referenced sections for concrete and joint fillers and sealers.

1.5 JOB CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects.

1. Use flexible spring steel forms or laminated boards to form radius bends as required.

2. Coat forms with a non-staining form release agent that will not discolor or deface surface of concrete.

B. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A 185.

1. Furnish in rolls, unless otherwise acceptable to Architect.

C. Reinforcing Bars: Deformed steel bars, ASTM A 615, Grade 40.

D. Joint Dowel Bars: Plain steel bars, ASTM A 615, Grade 40. Cut bars true to length with ends square and free of burrs.

E. Metal Expansion Caps: Furnish for one end of each dowel bar in expansion joints. Design caps with one end closed and a minimum length of 3 inches to allow bars movement of not less than 1 inch, unless otherwise indicated.

F. Hook Bolts: ASTM A 307, Grade A bolts, internally and externally threaded. Design hook bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

G. Concrete Materials: Comply with requirements of applicable Division-3 sections for concrete materials, admixtures, bonding materials, curing materials, and others as required.

H. Expansion Joint Materials: Comply with requirements of applicable Division-7 sections for preformed expansion joint fillers and sealers.

I. Anti-Spalling Compound: 50% (by volume) boiled linseed oil and 50% (by volume) mineral spirits, complying with AASHTO M-233.

J. Liquid-Membrane Forming Curing Compound: Complying with ASTM C 309, Type I, Class A unless other type acceptable to Architect. Moisture loss not more than 0.055 gr./sq. cm. when applied at 200 sq. ft./gal.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

"Masterseal"; Master Builders.
"A-H 3 Way Sealer"; Anti-Hydro Waterproofing Co.
"Ecocure"; Euclid Chemical Co.
"Clear Seal"; A.C. Horn.
"J-20 Acrylic Cure"; Dayton Superior.
"Sure Cure"; Kaufman Products Inc.
"Spartan-Cote"; The Burke Co.
"Sealkure"; Toch Div. - Carboline.
"Kure-N-Seal"; Sonneborn-Contech.
"Polyclear"; Upco Chemical/USM Corp.
"L&M Cure"; L & M Construction Chemicals.
"Klearseal"; Setcon Industries.
"LR-152"; Protex Industries.
"Hardtop"; Gifford - Hill.

K. Bonding Compound: Polyvinyl acetate or acrylic base, rewettable type.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

"J-40 Bonding Agent"; Dayton Superior Corp.
"Weldcrete"; Larsen Products.
"Everbond"; L & M Construction Chemicals.
"EucoWeld"; Euclid Chemical Co.
"Hornweld"; A. C. Horn.
"Sonocrete"; Sonneborn-Contech.
"Acrylic Bondcrete"; The Burke Co.

L. Epoxy Adhesive: ASTM C 881, two component materials suitable for use on dry or damp surfaces. Provide material "Type," "Grade," and "Class" to suit project requirements.

1. Available Products: Subject to compliance with requirements, products which may be

incorporated in the work include, but are not limited to, the following:

"Epoxtite"; A. C. Horn.
"Edoco 2118 Epoxy Adhesive"; Edoco Technical Prod.
"Sikadur Hi-Mod"; Sika Chemical Corp.
"Euco Epoxy 463 or 615"; Euclid Chemical Co.
"Patch and Bond Epoxy"; The Burke Co.
"Sure-Poxy"; Kaufman Products Inc.

2.2 CONCRETE MIX, DESIGN AND TESTING

A. Comply with requirements of applicable Division-3 sections for concrete mix design, sampling and testing, and quality control, and as herein specified.

Design mix to product normal-weight concrete consisting of portland cement, aggregate, water-reducing of high-range water-reducing admixture (super-plasticizer), air-entraining admixture and water to produce the following properties:

1. Compressive Strength: 3000 psi, minimum at 28 days, unless otherwise indicated.

2. Slump Range: 8 inches for concrete containing HRWR admixture (super- plasticizer); 3 inches for other concrete.

3. Air Content: 5% to 8%.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Remove loose material from compacted subgrade surface immediately before placing concrete.

Proof-roll prepared subbase surface to check for unstable areas and need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.

3.2 FORM CONSTRUCTION

A. Set forms to required grades and lines, rigidly braced and secured. Install sufficient quantity of forms to allow continuous progress of work and so that forms can remain in place at least 12 hours after concrete placement.

Check completed formwork for grade and alignment to following tolerances:

1. Top of forms not more than 1/8 inch in 10 feet.
2. Vertical face on longitudinal axis, not more than 1/4 inch in 10 feet.

Clean forms after each use, and coat with form release agent as often as required to ensure separation from concrete without damage.

3.3 REINFORCEMENT

A. Locate, place and support reinforcement as specified in Division-3 sections, unless otherwise indicated.

3.4 CONCRETE PLACEMENT

A. General: Comply with requirements of Division-3 sections for mixing and placing concrete, and as herein specified.

1. Do not place concrete until subbase and forms have been checked for line and grade. Moisten subbase if required 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.

2. Place concrete using methods which prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with 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 dislocation of reinforcing, dowels, and joint devices.

   Deposit and spread concrete in a continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2-hour, place a construction joint.

3. Fabricated Bar Mats: Keep mats clean and free from excessive rust, and handle units to keep them flat and free of distortions. Straighten bends, kinks, or other irregularities or replace units as required before placement. Set mats for a minimum 2 inches overlap to adjacent mats.

   Place concrete in 2 operations; strike-off initial pour for entire width of placement and to the required depth below finish surface. Lay fabricated bar mats immediately in final position. Place top layer of concrete, strike-off and screed.

   a. Remove and replace portions of bottom layer of concrete which has been placed more than 15 minutes without being covered by top layer or use bonding agent if acceptable to Architect.

3.5 JOINTS

A. General: Construct expansion, weakened-plane (contraction), and construction joints true-to-line with face perpendicular to surface of concrete. Construct transverse joints at right angles to the centerline, unless otherwise indicated.

   When joining existing structures, place transverse joints to align with previously placed joints, unless otherwise indicated.

1. Weakened-Plane (Contraction) Joints: Provide weakened-plane (contraction) joints, sectioning concrete into areas as shown on drawings. Construct weakened-plane joints for a depth equal to at least 1/4 concrete thickness, as follows:

   a. Tooled Joints: Form weakened-plane joints in fresh concrete by grooving top portion with a recommended cutting tool and finishing edges with a jointer.

2. Construction Joints: Place construction joints at end of placements and at locations where placement operations are stopped for a period of more than 1/2-hour, except where such placements terminate at expansion joints.

   a. Construct joints as shown or, if not shown, use standard wood or metal keyway-section forms.
   b. Where load transfer-slip dowel devices are used, install so that one end of each dowel bar is free to move.

3. Expansion Joints: Provide premolded joint filler for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, walks and other fixed objects, unless otherwise indicated.

Locate expansion joints at spacings indicated.

Extend joint fillers full-width and depth of joint, and not less than 1/2 inch or more than 1 inch below finished surface where joint sealer is indicated. If no joint sealer, place top of joint filler flush with finished concrete surface.

Furnish joint fillers in one-piece lengths for full width being placed, wherever possible. Where more than one length is required, lace or clip joint filler sections together.

Protect top edge of joint filler during concrete placement with a metal cap or other temporary material. Remove protection after concrete has been placed on both sides of joint.

4. Fillers and Sealants: Comply with the requirements of applicable Division-7 sections for preparation of joints, materials, installation, and performance.

3.6 CONCRETE FINISHING

A. After striking-off and consolidating concrete, smooth surface by screeding and floating. Use hand method only where mechanical floating is not possible. Adjust floating to compact surface and produce uniform texture.

After floating, test surface for trueness with a 10' straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide a continuous smooth finish.

Work edges of slabs, gutters, back top edge of curb, and formed joints with an edging tool, and round to 1/2 inch radius, unless otherwise indicated. Eliminate tool marks on concrete surface.

After completion of floating and troweling when excess moisture or surface sheen has disappeared, complete surface finishing, as follows:

1. Broom finish, by drawing a fine-hair broom across concrete surface, perpendicular to line of traffic. Repeat operation if required to provide a fine line texture acceptable to Architect.

2. On inclined slab surfaces, provide a coarse, non-slip finish by scoring surface with a stiff-bristled broom, perpendicular to line of traffic.

Do not remove forms for 12 hours after concrete has been placed. After form removal, clean ends of joints and point-up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by Architect.

3.7 CURING

A. Protect and cure finished concrete paving, complying with applicable requirements of Division-3 sections. Use membrane- forming curing and sealing compound or approved moist-curing methods.

3.8 REPAIRS AND PROTECTIONS

A. Repair or replace broken or defective concrete, as directed 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 pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

Sweep concrete pavement and wash free of stains, discolorations, dirt and other foreign material just prior to final inspection.

END OF SECTION

SECTION 31 25 77 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Pavement markings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Asphalt concrete paving - Section 02513

1.3 SUBMITTALS

A. Procedure: Submit in accord with General Conditions.

B. Product data: Submit manufacturer's detailed literature.

PART 2 - MATERIALS

2.1 A. Pavement marking paint: Tnemec's Traffic Paint, Glidden-Durkee's Romark Traffic, PPG's Traffic and Zone Marking

1. Provide marking paint for perimeter and marking outside traffic flow patterns or in areas where existing markings have been disturbed.

PART 3 - EXECUTION

3.1 PAINT MARKINGS APPLICATION

A. Obtain approval of marking layouts prior to paint application.

B. Traffic line markings: 4 inches wide unless otherwise indicated.

C. Machine apply in strict accord with recommendations of paint manufacturer.

D. Apply two coats or more as required for complete opacity.
1. Apply first coat after all paved surfaces to be painted are dry and cured for a minimum of 48 hours.
2. Apply second or final coat prior to completion of project.

E. Paint directional lettering, arrows and other markings by similar methods with same paint. Use stencils and masking tape as required to achieve required designs.

END OF SECTION

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SECTION 31 25 80 - CONCRETE CURBS AND WALKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. General: Furnish all labor and materials to construct concrete curbs and gutters, sidewalks including ramps, and driveways as called for in the Drawings and detailed in the Standard Detail Drawings to include excavation and backfill; foundation; and forming, placing, jointing, form removing, finishing and curing concrete.

PART 2 - MATERIALS

2.1 Concrete: FDOT 345-2 (except no pozzolan), 4, 6, 9, 10, 11, 12, 13. Class I concrete with minimum 28-day compressive strength of 3000 psi.

2.2 Reinforcement: ASTM A615 - Grade 60.

2.3 Joint Materials: FDOT 932-1.

2.4 Membrane Curing Compound: FDOT 925-2.

2.5 Forms: Forms shall be metal or wooden, straight, and free from warp or bends and of sufficient strength, when staked to resist the pressure of the concrete without deviation from line and grade. Flexible forms shall be used for all items constructed on a radius.

PART 3 - EXECUTION

3.1 Foundation (Subgrade Preparation): The subgrade shall be excavated or filled with suitable material to the required grades and lines. All soft, yielding, and otherwise unsuitable material shall be removed and replaced with suitable material. Filled sections shall be compacted to a minimum of 95% of maximum (AASHTO T-180) density and extend to a minimum of 1 foot outside the form lines. The subgrade shall be dense, firm, trimmed to a uniform smooth surface, and in a moist condition when the concrete is placed.

3.2 Machine Laid Curb: The slipform/extrusion machine approved shall be so designed as to place a spread, consolidate, screed, and finish the concrete in one complete pass in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous concrete section. The machine shall shape, vibrate, and/or extrude the concrete for the full width and depth of the concrete section being placed. It shall be operated with as nearly a continuous forward movement as possible. All operations of mixing, delivery, and spreading concrete shall be so coordinated as to provide uniform progress, with stopping and starting of the machine held to a minimum.

3.3 Forming: Depth of forms shall be equal to the Drawing dimensions for the concrete to be placed against them. Forms shall be staked to resist the pressure of the concrete without deviation from line and grade. They shall be cleaned each time used and shall be oiled or saturated with water prior to placing concrete.

3.4 Reinforcement: Reinforcement shall only be required where called for in the Drawings. Set reinforcement for sidewalks above the foundation so concrete will flow under it.

3.5 Placing: Place concrete in the forms and tamp and spade to prevent honeycomb until the top of the structure can be floated smooth. Round all edges to 1/2 inch radii unless otherwise shown on the Standard Detail Drawings.

3.6 Sidewalk Ramps: Ramps shall be provided at all road/street crossings each way as shown in the Standard Detail Drawings.

3.7 Contraction Joints: Unless otherwise shown or noted in the Drawings, weakened plane contraction joints shall be located as follows:

Curbs - 10 feet maximum intervals.

Sidewalks - To form squares of uniform size.

3.8 Contraction joints may be sawed, hand-formed, or made by 1/8 inch thick division plates in the framework. Sawing shall be done early after the concrete has set to prevent the formation of uncontrolled cracking. The joints may be hand-formed by using a narrow or triangular jointing tool or a thin metal blade to impress a plane of weakness into the plastic concrete. Where division plates are used, the plates shall be removed after the concrete has set and while the forms are still in place.

3.9 Expansion (Isolation) Joints: Provide isolation joints between all distinct structures such as between sidewalk and curbs, driveway and sidewalk or curbs, sidewalk or curbs and inlets, around concrete utility poles and at radius points along the curbs and at the end of a continuous pour.

3.10 Finishing: Strike off concrete sidewalks and driveways by means of a wood or metal screed, used perpendicular to the forms, to obtain required grade and remove surplus water laitance. Broom finish the surfaces and finish edges with an edging tool having a radius of 1/2 inch.

3.11 Remove all curb and gutter forms within 24 hours after concrete is in place, and fill minor defects with mortar composed of one part portland cement and two parts fine aggregate. Plastering is not permitted. Finish all curbs and gutter surfaces while the cement is still green to a brush finish. For any surface areas that are too rough or where surface defects make additional finishing necessary, the curb shall be rubbed to a smooth surface with a soft brick or wood block, with water used liberally.

3.12 Surface Requirements: Test the gutters with a 20 foot straight edge laid parallel to the centerline of the roadway while the concrete is still plastic. Straight edging shall be done along the edge of the gutter adjacent to the pavement or along other lines on the gutter cross-section. Irregularities in excess of 1/4 inch shall be corrected immediately. Surface variations on sidewalks and driveways shall not exceed 1/4 inch under a 10 foot straight edge, nor more than 1/8 inch on a 5 foot traverse section.

3.13 Curing: Concrete shall be cured by the Membrane Curing Compound Method for a continuous period of 72 hours minimum, commencing after completing the finishing and as soon as the concrete has hardened sufficiently to permit application of the curing material without marring the surface. Immediately replace any curing material that may be removed or damaged during the 72-hour period.

This method requires the application of a clean membrane curing compound or white pigmented curing compound as in the Membrane Curing Compound paragraph above, by a hand sprayer in a single continuous film with uniform coverage of at least one gallon to each 200 square feet. Any cracks, check or other defects shall be recoated immediately. Agitate the curing compound thoroughly in the drum prior to application, and during application as necessary to prevent settlement of the pigment.

3.14 Backfilling and Compaction: After the concrete has set sufficiently, but no later than 3 days after the pouring, the spaces in front and back of the curb and other excavation generated from this work shall be refilled to the required elevation with suitable material, placed and thoroughly compacted in layers not to exceed 6 inches.

3.15 Protection: The Contractor shall always have materials available to protect the surface of the plastic concrete against rain. These materials shall consist of waterproof paper or plastic sheeting. For slipform construction, materials such as wood planks or forms to protect the edges shall also be required.

3.16 Testing: Provide not less than three 6 inches by 12 inches cylinder compressive strength tests (ASTM C 39) and one slump test (ASTM C 143) for each 75 cubic yards of part thereof poured.

END OF SECTION

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SECTION 31 26 66 - POTABLE WATER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to work of this Section.

1.2 DESCRIPTION OF WORK

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

B. Refer to Section 31 22 10 "EARTHWORK - UNDERGROUND UTILITIES" for excavation and backfill required for potable water systems; not work of this section.

C. Refer to Division-22 for interior building water systems including interior piping, fixtures, and equipment; not work of this section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of potable water systems materials and products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with potable water piping work similar to that required for project.

C. Codes and Standards:

1. AWWA C-600 for Ductile Iron and install PVC as applicable.
2. AWWA C-900 for PVC pipe 4 inch to 12 inch.
3. Water Purveyor Compliance: Comply with requirements of Purveyor supplying water to project, obtain inspections from Purveyor as outlined in this section.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for potable water system materials and products.

B. Shop Drawings: Submit shop drawings for potable water systems, showing piping materials, size, locations, and elevations. Include details of underground structures, connections, thrust blocks, and anchors. Show interface and spatial relationship between piping and proximate structures.

C. Record Drawings: At project closeout, submit record drawings of installed potable water system piping and products, in accordance with requirements of Division-1.

D. Maintenance Data: Submit maintenance data and parts lists for potable water system materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual; in accordance with requirements of Division-1, if applicable.

PART 2 - PRODUCTS

2.1 IDENTIFICATION

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

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering plastic line markers which may be incorporated in the work include, but are not limited to, the following:
   a. Allen Systems Inc.
   b. Seton Name Plate Corp.
   c. or approved equal

B. Nonmetallic Piping Label: If nonmetallic piping is used for water service, provide engraved plastic laminate, label permanently affixed to main electrical meter panel stating "This structure has a nonmetallic water service."

2.2 PIPES AND PIPE FITTINGS

A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, and capacities as indicated. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in potable water systems.

B. Piping: Provide pipes of one of the following materials, of weight/class indicated.

C. Iron Pipe & Fittings: Pipe shall be ductile iron (DI) with minimum thickness of Class 51 for 3 and 4 inch diameter pipe and Class 50 for larger pipe. Fittings may be ductile iron or gray iron (GI) with pressure rating equal to that of the pipe unless otherwise specified in the Drawings. The materials shall be as follows:

1. Pipe - ANSI A21.51 (AWWA C151)
2. Fittings - ANSI A21.10 (AWWA C110)
3. Joints - Mechanical & Push-on, ANSI A21.11 (AWWA C111)
4. Joints - Flanged ANSI A21.10 & A21.15 (AWWA C110 & C115) Class 125 and 1/8 inch full faced rubber gaskets.
5. Restrained joints - Ductile iron mechanical joint retainer glands approved equal to American Cast Iron Pipe Co.
6. Flexible joints - Boltless with 15 joint deflection per applicable portions of ANSI A21.10 (AWWA C110) approved equal to "Flex-Lok" by American Cast Iron Pipe Co.
7. Bolts & Nuts - Bolts, ANSI B18.21; Nuts, B18.2.1; low carbon steel per ASTM A307, Grade B.

D. Coatings, Linings & Encasement (Iron Pipe): All pipe and fittings shall be cement mortar lined per ANSI A21.4 (AWWA C104) and bituminous coated per above.

1. Where protective interior lining is called for, use 20 mil (minimum dry thickness) virgin polyethylene per ASTM D1248 compounded with an inert filler and with sufficient carbon black to resist ultraviolet rays during above ground storage, heat bonded to pipe and fittings, approved equal to "Polybond" by American Cast Iron Pipe Company.
2. Polyethylene Encasement, where required, shall be per ANSI A21.5 (AWWA C105).
3. Pipe fittings scheduled for field painting shall not receive an exterior bituminous coating. Instead, the pipe and fitting exterior shall be cleaned thoroughly and given one (1) shop coat of rust-inhibitive primer compatible with the field paint applied in accordance with the manufacturer's recommendations.
4. Machined surfaces shall be cleaned and coated with a suitable rust-preventative coating at the shop immediately after machining.

E. Polyvinyl Chloride Pipe (PVC): 4 inch to 12 inch AWWA C900, DR-18 National Sanitation Foundation (NSF) approved for potable water having integral wall-thickened bell ends without increase in DR and outside diameter equivalent to ductile iron pipe. Use iron fitting per above. Joints shall be elastomeric seals per ASTM D3139 and ASTM F477. Lubrication shall be non-toxic, NSF approved for potable water. Polyvinyl chloride pipe less than 4 inches shall be in accordance with ASTM 1785 for schedule 40, 80, 120 or ASTM 2241 for SDR21, minimum PC 200.

F. Check Valves: Iron body, bronze-mounted, stainless steel hinge pin, outside spring operated, swing non-slam type, and equipped with removable inspection covers. Units shall be rated for 150 psi minimum working pressure and shall permit full flow area equal to that of the connecting pipe. Approved equal to M & H.

Valves 2 inches and smaller - bronze body and disc, swing check type, with removable inspection covers, rated at 150 psi minimum working pressure, equal to Crane No. 37.

G. Valve Boxes: Cast iron, adjustable, with minimum interior diameter of 5 inches. The word "Water" shall be legibly cast into the cover. Boxes to conform to applicable surface loading and valve size approved equal to Clow.

H. Valves-General: The manufacturer shall clearly mark the valve type, size, rating and flow direction arrow. Valves shall open to the left (counter-clockwise) with an arrow cast in the metal of the operating handwheels and nuts indicating the direction of opening. Above ground installations shall have flanged joints; below ground shall be mechanical joints.

I. Gate Valves: Iron body, bronze-mounted double disc, 0-ring seal, per AWWA C500. Valves for underground service shall be non-rising stem (NRS) type equipped with 2 inch square cast iron wrench nuts. Valves for above ground service shall be outside screw and yoke (OS & Y) rising stem type equipped with cast iron band wheels or chain operators with galvanized steel chains as noted in the Drawings.

1. Tapping valves - per the above, compatible with the connecting sleeve or saddle and specially designed for wet tapping installations.
2. Actuators - Equip all valves 16-inch and larger with approved gearing actuators, with sealed enclosures for buried or submerged service, and shall be furnished by the valve manufacturer. Position indicators as required.
3. Horizontal Installation - Valves 16-inches in diameter or larger, to be installed horizontally, shall be additionally equipped per the applicable Section of AWWA C500 and as follows:
   a. Installed in vertical pipe with horizontal stem-fitted with approved slides, tracks and shoes to assist the travel of the gate assembly.
   b. Installed in Horizontal pipe with horizontal stem - equipped with approved rollers, tracks and scrapers to assist the travel of the gate assembly and to clear the tract of obstructions.
4. Valves 3-inches and smaller - Bronze, wedge disc, non-rising stem type, 150 psi minimum working pressure, equipped with wrought steel or cast iron operating handwheels, approved equal to Crane No. 437.

J. Butterfly Valves: Cast iron body, allow cast or ductile iron disc, body mounted at seat, one-piece stainless steel shaft, short or long body type, AWWA C504, with the valve class, shaft size and other special requirements selected in accordance with the specific design, "Rubber-Seated Butterfly Valves". Valve operation by approved gear actuators, with sealed enclosures for buried or submerged service. Position indicators furnished as required. Equip units with actuating nuts, cast iron handwheels or chain operators, with galvanized steel chains for the given installation. All appurtenances furnished by valve manufacturer.

K. Backflow Prevention Device: Type and manufacturer shown in the Drawings, otherwise per AWWA C-506, however the device shall be acceptable to the local jurisdiction. Approved equal to Hersey (Beeco), CLa-Val, Febco, Grinnel.

L. Meter Box: Cast-iron or concrete standard types, appropriately sized for utilization and installation requirements.

M. Expansion Joints: Pipe expansion joints shall be minimum 150 psi working pressure equal to style N. 500, manufactured by Mercer Rubber Company.

N. Flanged Coupling Adapters: Equal to Smith Blair Type 912 for pipe size to 12 inches and Type 913 for larger sizes. Conformance with ANSI Standard B16.1 (125 lb flanges).

O. Cast Couplings: Equal to Smith Blair, Type 431 (connecting equal outside diameter pipes), Type 433 (connecting equal size pipes with variations in outside diameter), and Type 435 (reducing coupling).

P. Cast Iron Sleeves and Wall Pipes: Shall have integral annular ring water-stops, and conform to requirements for Cast Iron fittings noted herein. Sleeves and Wall Pipes to have laying length and ends required for proper installation.

Q. Tapping Saddles: Ductile Iron, suitable for either wet or dry installation double strapped as manufactured by the American Cast Iron Pipe Company. Provide an "O"-ring type sealing gasket. Provide tie straps and bolts of a corrosive resistant alloy steel.

R. Tapping Sleeves and Crosses: mechanical joint type, with outlet flange ANSI B16-1, 125 lb standard, approved equal to M & H.

S. Service Saddle: Double strap units with straps of corrosion resistant alloy steel and "O"-ring type sealing gasket. Ductile iron for ductile iron pipe, equal to Smith Blair Type 3.3. Type 342 or 352 for plastic pipe.

T. Service Line Materials: AWWA C800 and the Appendix thereto where applicable. The minimum pressure class for plastic piping/tubing shall be 200 psi.

U. Concrete: FDOT 345 - 2, 4, 6, 9, 10, 11, 12 and 23. Class II concrete, minimum 28 day compression strength of 3400 psi.

2.3 ACCESSORIES

A. Anchorages: Provide anchorages for tees, wyes, crosses, plugs, caps, bends, valves, and hydrants. After installation, apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of ferrous anchorages.
   1. Clamps, Straps, and Washers: Steel, ASTM A 506.
   2. Rods: Steel, ASTM A 575.
   3. Rod Couplings: Malleable-iron, ASTM A 197.
   4. Bolts: Steel, ASTM A 307.
   5. Cast-Iron Washers: Gray-iron, ASTM A 126.
   6. Thrust Blocks: Concrete, 3,000 psi, as indicated on drawings.

B. Yard Hydrants: Provide non-freeze yard hydrants, 3/4 inch inlet, 3/4 inch hose outlet, bronze casing, cast-iron or cast-aluminum casing guard, key-operated, and tapped drain port in valve housing.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering yard hydrants which may be incorporated in the work include, but are not limited to, the following:
   a. Josam Mfg. Co.
   b. Smith (Jay R.) Mfg. Co.
   c. Tyler Pipe.
   d. Zurn Industries, Inc.; Hydromechanics Div.

2.4 FIRE HYDRANTS

A. AWWA C502, and shall be equipped with a minimum of one pumper outlet nozzle 4-1/2 inches in diameter and two hose nozzles 2-1/2 inches in diameter. Paint hydrant with two coats of oil paint using the local color code based on fire flow tests. Threads, nozzle caps, operating nuts and color shall conform to requirements of the local jurisdiction. Units shall be traffic type with breakable safety clips, or flange, and stem, with safety coupling located below barrel break line to preclude valve opening. Hydrants shall be dry top, low profile design with a maximum height of 30 inches. Outlet nozzles shall be on the same plane, with minimum distance of 18 inches from center of nozzles to ground line. Valve shall be compression type with 5-1/2 inches minimum opening and shoe inlet connection to be 6 inches minimum.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Examine areas and conditions under which potable water system's materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF IDENTIFICATION

A. General: During back-filling/top-soiling of underground potable water piping, install continuous underground-type plastic line markers, located directly over buried lines at 24 inches below finish grade.

B. Insulation: Insulate all above ground piping for freeze protection.

C. Pipe Laying: Lay all pipe "in the dry" along straight lines and grades between fittings, manholes, or other defined points, unless definite alignments deflections or grade changes are noted in the Drawings. Maintain a 3 foot minimum depth of cover over the top of pipe, unless otherwise noted in the Drawings. Maintain all materials, clean and protect all coatings from damage. Maintain the interior of the pipe, clean and free of dirt and debris. When work is not in progress, plug all open ends. Underground piping shall not be driven to grade by striking it with an unyielding object. Provide bell holes in the bedding to allow uniform load bearing along the pipe barrel.

Subaqueous pipe laying may be permitted with prior approval of the Engineer where conditions make it impracticable to lay pipe "in the dry".

Provide proper provisions for pipe expansions or contraction by installing expansion joints or other suitable methods. Also provide flexible connections to expedite equipment or piping system removal.

D. Push-On Joints: The pipe bell and spigot shall be thoroughly cleaned immediately prior to inserting the gasket and jointing. Assure that the gasket is properly faced and positioned. Lubricate in accordance with manufacturer's recommendations. Protect pipe against damage from jointing equipment by using timber headers, etc.

E. Mechanical Joints: Wipe clean the socket and plain end. The plain end, socket, and gasket shall be washed with a soap solution immediately prior to jointing. Maintain the joint straight during assembly with the gasket pressed firmly and evenly into the recess. Bolts shall be tightened such that the gland remains reasonable parallel to the flange by alternating from bolt to bolt in cycles. The required bolt size (pipes 4 inch to 24 inch diameter) is 3/4 inch torqued to 75 - 90 ft-lbs.

F. Flange Joints: Make all flanged joints tight, without applying undue strain upon the joint or other appurtenances. Fit joints such that contact surfaces bear uniformly on the gasket with relatively uniform bolt stresses.

G. Pipe Cutting: Cutting pipe for the insertion of valves, fittings, or closure pieces shall be done in a neat workmanlike manner without damaging pipe, coatings or linings. Cut the pipe with an abrasive pipe saw, rotary wheel cutter, guillotine pipe saw or milling wheel saw, and per manufacturer's recommendations. Cut ends and rough edges shall be ground smooth, and for push-on joint connections the cut end shall be beveled.

H. Pipe Restraint: All plugs, caps, tees, and bends, unless otherwise specified, shall be restrained by thrust block reaction backing and/or the use of tie rods, retainer glands and/or restrained joints as shown in the Drawings and Standard Detail Drawings. Thrust blocking shall be placed between solid ground and the fitting to be anchored. Where concrete is to be placed around bolted joints, provide a sheet of 3 mil (minimum) polyethylene between the fitting and the concrete. Where soil bearing is inadequate to provide proper thrust blocking, Contractor shall provide mechanical restraint as directed by the Engineer. Protect tie rods, clamps, or other components of dissimilar metal against corrosion by hand application of a bituminous coating. Backfilling over pipe restraints shall not proceed until inspected by the Engineer.

I. Polyethylene Encasement: When polyethylene encasement is specified for ductile iron pipe it shall be installed in accordance with ANSI A21.5 (AWWA C105).

J. Support of Exposed Pipework: Support exposed systems as necessary to hold the piping and appurtenances in a firm, substantial manner to the required line and grades indicated on the Drawings, with no undue piping stresses transmitted to equipment or other items. Support all piping in buildings from the floors, wall, ceiling and beams adequately. Supports from the floor shall be by suitable saddle stands or piers. Support piping along walls by wall brackets, saddles or by wall brackets with adjustable hanger rods. When piping is supported from the ceiling, use approved rod hanger of a type capable of screw adjustment after erection. Support all pipe above ground outside of buildings by concrete supports.

Where floor stands and extension stems are required for exposed valves, furnish adjustable wall bracket and extension stems. In general, brackets shall be not more than 6 feet apart, with floorstands and guides set firmly in concrete.

K. Tapping: Tapping shall be by tapping sleeve (or cross) and valve installed with a tapping device designed for the pipe material.

L. Service Connections: All connections less than 1 □-inches are considered service connections. New services shall be no less than 3/4-inches in diameter, unless noted otherwise on the drawings. Service lines serving a double connection shall be no less than 1-inch in diameter, unless noted on the drawings. Connection to main 4-inch and larger shall be by drilling the appropriate size hole and installation of service saddle with services to smaller mains by means of in-line fittings. Place a corporation stop at the saddle or fitting, extend service line to property line (perpendicular from the Main), and terminate with a plugged curb-stop pending meter installation. The contractor shall mark the location of each water service at its upper end by chiseling a letter "W" - 1 □-inches high on the top of the curb. If the curb does not exist, place a 4" x 4" x 3'-0" wood stake extending 2-inches above the ground at the end of the service.

M. Valves: Carefully inspect all valves, opened wide, and then tightly closed, and all the various nuts and bolts for tightness. Take special care to prevent joint materials, stones, and other substances from becoming lodged in the valve seat. Any valve that does not operate correctly shall be replaced. Install at the locations, to the sizes, and elevations called for in the Drawings. Install buried valves vertically centered over the pipe. Provide extension stems on all buried valves to place the operating nut not more than 3 feet below grade.

N. Valve Boxes: Center all valve boxes over the operating nut of underground valves to permit a valve wrench to be easily fitted to the nut. Set top of boxes to final grade. The valve box shall not transmit surface loads directly to either the pipe or valve. Use excessive care to prevent earth and other materials from entering the boxes. Any valve box that becomes out of alignment or is not to grade, shall be dug out and adjusted. A concrete collar shall be provided as shown in the Drawings.

3.3 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered, and after thrust blocks have sufficiently hardened. Fill pipeline 24- hrs prior to testing, and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than 150 psi for 2 hours.

This test shall be performed by the Contractor with his labor and equipment in the presence of the Engineer and Owner/Purveyor Representative. No testing will proceed until all thrust blocks are cured or restraining devices installed. Clean and flush all piping thoroughly prior to testing. During filling of water all air will be carefully permitted to escape through release cocks installed as required.

$$L = \frac{(N)\ (D)\ (P)^{\square}}{3700}$$ = allowable leakage in gallons per 2 hour test.

L = 0.00331 ND; for 150 psi test for 2 hours.

N = Number of joints in the section tested.

D = Nominal pipe diameter in inches.
P = Average test pressure maintained during the leakage test in psig (gauge).

During the two (2) hour period of the test, the Contractor shall maintain a continuous pressure of 150 psi, by means of a pump taking supply from a container suitable for the measurement of water loss. Should the test fail, the leak will be located and repaired and the test performed again until it meets the above specified limits.

C. Disinfection - Following the hydrostatic leakage test, Contractor shall provide all labor and materials to disinfect all sections of water systems, and receive approval from the appropriate agencies before placing the system in service. Disinfection shall be performed per AWWA C651 and Florida Department of Environmental Protection requirements.

D. Chlorination - Apply the chlorination agent at the beginning of the section adjacent to the feeder connection, by injecting it through a corporation cock, hydrant or other connection ensuring treatment of the entire system. The chlorination agent may be any compound specified in AWWA C651. Feed water slowly into the new line and induce chlorine to produce a dosage and a residual as a dosage of between 40-50 ppm and a residual of not less than 25 mg/1 in all parts of the line after a 24-hour time period. During the chlorination process operate all valves and accessories.

E. Flushing - Flush the system carefully until the chlorine concentration in the discharged water is equal to that generally prevailing or less than 1mg/1.

F. Bacteriological Testing - After disinfecting the system, Contractor shall have samples collected for bacteriological analysis and submit as directed by Florida Department of Environmental Protection or local governing authority.

G. Inspection of Work - All work is subject to inspection by the Water Purveyor, Owner's Representative and Engineer. The following phases of construction shall be inspected by the Owner's Representative and Engineer:

Placing of pipe, fittings and appurtenances.
Hydrostatic Test
Backfill
Sterilization
Placing in Service

END OF SECTION

SECTION 31 26 68 - FIRE WATER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to work of this Section.

1.2 DESCRIPTION OF WORK

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

B. Refer to section -31 22 10 "EARTHWORK/UNDERGROUND UTILITIES" for excavation and backfill required for fire water systems; not work of this section.

C. Refer to Division-3 sections for concrete work required for fire water systems; not work of this section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fire water system's products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with fire water work similar to that required for project.

C. Codes and Standards:

1. NFPA Compliance: Install fire water systems in accordance with NFPA 24 "Standard for the Installation of Private Fire Service Mains and Their Appurtenances."

2. Local Fire Department/Marshal Regulations: Comply with governing regulations pertaining to hydrants, including hose unit threading and similar matching of connections.

3. UL Compliance: Provide fire hydrants that comply with UL 246 "hydrants for fire protection service" and are listed by UL.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for fire water system materials and products.

B. Shop Drawings: Submit shop drawings for fire water systems, showing piping materials, size, locations, and elevations. Include details of underground structures, connections, thrust blocks, and anchors. Show interface and spatial relationship between piping and proximate structures.

C. Record Drawings: At project closeout, submit record drawings of installed fire water system piping and products, in accordance with requirements of Division-1.

D. Maintenance Data: Submit maintenance data and parts lists for fire water system materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual; in accordance with requirements of Division-1, if applicable.

PART 2 - PRODUCTS

2.1 IDENTIFICATION

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

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering identification markers which may be incorporated in the work include, but are not limited to, the following:

a. Allen Systems Inc.
b. Seton Name Plate Corp.

2.2 PIPES AND PIPE FITTINGS

A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Provide materials and products complying with NFPA 24 where applicable. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in fire water piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.

1. Iron Pipe & Fittings: Pipe shall be ductile iron (DI) with minimum thickness of Class 51 for 3 and 4 inch diameter pipe and Class 50 for larger pipe. Fittings may be ductile iron or gray iron (GI) with pressure rating equal to that of the pipe unless otherwise specified in the Drawings. The materials shall be as follows:

a. Pipe: - ANSI A21.51 (AWWA C151)

b. Fittings - ANSI A21.10 (AWWA C110)

c. Joints - Mechanical & Push-on, ANSI A21.11 (AWWA C111)

d. Joints - Flanged ANSI A21.10 & A21.15 (AWWA C110 & C115) Class 125 and 1/8 inch full faced rubber gaskets.

e. Restrained Joints: - Ductile iron mechanical joint retainer glands approved equal to American Cast Iron Pipe Co.

f. Flexible Joints - Boltless with 15 joint deflection per applicable portions of ANSI A21.10 (AWWA C110) approved equal to "Flex-Lok" by American Cast Iron Pipe Co.

g. Bolts & Nuts - Bolts, ANSI B18.21; Nuts, B18.2.1; low carbon steel per ASTM A 307, Grade B.

2. Polyvinyl Chloride Pipe (PVC): 4 inch to 12 inch AWWA C900, Class 150, having integral wall-thickened bell ends without increase in DR and outside diameter equivalent to ductile iron pipe. Use iron fitting per above. Joints shall be elastomeric seals per ASTM D 3139 and ASTM F 477. Lubrication shall be non-toxic, NSF approved for potable water. Polyvinyl chloride pipe less than 4 inches shall be Schedule 40, unless otherwise noted on construction drawings.

3. Coatings, Linings & Encasement (Iron Pipe): All pipe and fittings shall be cement mortar lined per ANSI A21.4 (AWWA C104) and bituminous coated per above.

   Where protective interior lining is called for, use 20 mil (minimum dry thickness) virgin polyethylene per ASTM D 1248 compounded with an inert filler and with sufficient carbon black to resist ultraviolet rays during above ground storage, heat bonded to pipe and fittings, approved equal to "Polybond" by American Cast Iron Pipe Company.

   Polyethylene Encasement, where required, shall be per ANSI A21.5 (AWWA C105).

4. Pipe fittings scheduled for field painting shall not receive an exterior bituminous coating. Instead, the pipe and fitting exterior shall be cleaned thoroughly and given one (1) shop coat of rust-inhibitive primer compatible with the field paint applied in accordance with the manufacturer's recommendations.

5. Machined surfaces shall be cleaned and coated with a suitable rust-preventative coating at the shop immediately after machining.

2.3 VALVES

A. Gate Valves: Provide gate valves, UL-listed, 175 psi working pressure for 12 inches and smaller, 150 psi for sizes larger than 12 inches. Provide threaded, flanged, hub, or other end configurations to suit size of valve and piping connection. Provide inside screw type for use with indicator post, iron body bronze mounted, non-rising stem, solid wedge disc.

   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering gate valves which may be incorporated in the work include, but are not limited to, the following:

      American Valve Mfg. Corp.
      American-Darling Valve; Div. of American Cast Iron Pipe Co.
      Clow Corp.; Valve Div.
      Fairbanks Co.
      Kennedy Valve; Div. of ITT Grinnell Valve Co., Inc.
      Stockham Valves & Fittings Inc.
      United Brass Works Inc.
      United States Pipe and Foundry Co.
      Waterous Co.
      Mueller Co.

B. Indicator Posts: Provide indicator posts, UL-listed, designed for use with underground gate valves to provide aboveground means for operating valves and indicating position of valves. Provide telescopic barrel type with indicating target, intended for use with gate valves 4 inches through 14 inches, with operating wrench.

   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering indicator posts which may be incorporated in the work include, but are not limited to, the following:

American-Darling Valve; Div. of American Cast Iron Pipe Co.
Clow Corp.; Valve Div.
Eddy-Iowa; Div. Clow Corp.
Fairbanks Co.
Grinnell Fire Protection Systems Co., Inc.
Kennedy Valve; Div. of ITT Grinnell Valve Co., Inc.
Mueller Co.
Standard Fire Protection Co.
Stockham Valves & Fittings Inc.
United States Pipe and Foundry Co.
Waterous Co.

C. Butterfly Valves: Provide butterfly valves, UL-listed, 175 psi working pressure for 2 inches through 12 inches, 150 psi for sizes larger than 12 inches. Provide gear actuator and position indicator.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering butterfly valves which may be incorporated in the work include, but are not limited to, the following:

Demco; Div. of Cooper Industries Inc.
ITT Grinnell; Div. of ITT Industries of Canada Ltd.
Kennedy Valve; Div. of ITT Grinnell Valve Co., Inc.
Keystone Valve; Div. of Keystone International Inc.
Nibco Inc.
Powell (Wm.) Co.
Pratt (Henry) Co.
Tomoe Valve Co. Ltd.
Mueller Co.

D. Check Valves: Provide check valves as indicated, UL-listed, 175 psi working pressure for 2 inches through 12 inches, 150 psi for sizes larger than 12 inches. Provide swing type, iron body bronze mounted with metal- to-metal or rubber-faced checks. Provide threaded, flanged, or hub end, to suit size and piping connections.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering check valves which may be incorporated in the work include, but are not limited to, the following:

American-Darling Valve; Div. of American Cast Iron Pipe Co.
Clow Corp.; Valve Div.
Fairbanks Co.
Kennedy Valve; Div. of ITT Grinnell Valve Co., Inc.
Mueller Co.
Nibco Inc.
Stockham Valves & Fittings Inc.
Walworth Co.
Waterous Co.

E. Detector Check Valves: Provide detector check valves as indicated, UL listed, 175 psi working pressure. Provide iron or brass bodied with weighted clapper and provisions for connection of by-pass meter around check.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering detector check valves which may be incorporated in the work include, but are not limited to the following:

   Ames Co., Inc.
   Central Sprinkler Corp.
   Firematic Sprinkler Devices Inc.
   Globe Fire Equipment Co.
   Hersey Products Inc.
   Kennedy Valve; Division of ITT Grinnel Valve Co., Inc.
   Mueller Co.
   Reliable Automatic Sprinkler Co., Inc.
   Viking Corp.

F. Fire Hydrant: AWWA C502, and shall be equipped with a minimum of one pumper outlet nozzle 4-1/2 inches in diameter and two hose nozzles 2-1/2 inches in diameter. Paint hydrant with one coat of red-lead and two coats of oil point using the local color code based on fire flow tests. Threads, nozzle caps, operating nuts and color shall conform to requirements of the local jurisdiction. Units shall be traffic type with breakable safety clips, or flange, and stem, with safety coupling located below barrel break line to preclude valve opening. Hydrants shall be dry top, low profile design with a maximum height of 30 inches. Outlet nozzles shall be on the same plane, with minimum distance of 18 inches from center of nozzles to ground line. Valve shall be compression type with 5-1/2 inches minimum opening and shoe inlet connection to be 6 inch minimum.

2.4 ACCESSORIES

A. Anchorages: Provide anchorages for tees, wyes, crosses, plugs, caps, bends, valves, and hydrants. After installation, apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of ferrous anchorages.

1. Clamps, Straps, and Washers: Steel, ASTM A 506.
2. Rods: Steel, ASTM A 575.
3. Rod Couplings: Malleable-iron, ASTM A 197.
4. Bolts: Steel, ASTM A 307.
5. Cast Iron Washers: ASTM A 126.
6. Thrust Blocks: As Indicated on Drawings.

B. Valve Pits: Provide valve pits as indicated, constructed of poured-in-place or precast concrete. Construct of dimensions indicated with manhole access, ladder, and drain. Provide sleeves for pipe entry and exit; provide waterproof sleeve seals. If valve pit not below water table, provide open bottom filled with 3/4 gravel.

PART 3 - EXECUTION

3.1 INSTALLATION OF IDENTIFICATION

A. General: During back-filling/top-soiling of underground fire water piping systems, install continuous underground-type plastic line marker, located directly over buried line at 24 inches below finished grade.

3.2 INSTALLATION OF PIPE AND PIPE FITTINGS

A. Ductile-Iron Pipe: Install in accordance with AWWA C600 "Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances."

B. Polyvinyl Chloride Pipe: Install in accordance with manufacturers's installation instructions.

C. Steel Pipe: Install in accordance with AWWA M11 "Steel Pipe-Design and Installation."

D. Depth of Cover: Provide minimum 36 inches depth of cover over underground piping in accordance with NFPA 24, Figure A-8-11 "Recommended Depth of Cover Above Top of Underground Yard Mains."

3.3 INSTALLATION OF VALVES

A. General: Install valves as indicated. Provide post indicator for control valves.

B. Control Valves: Install post indicator valve at each connection into building, locate 40 ft. from building's outside wall, or as indicated.

C. Shutoff Valves: Install shutoff valve ahead of each hydrant.

3.4 INSTALLATION OF HYDRANTS

A. General: Install fire hydrants in accordance with AWWA M17 "Installation, Operation, and Maintenance of Fire Hydrants."

B. Location: Install fire hydrants minimum of 40 feet-0 inches from building's outside wall, or as indicated.

3.5 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered, and after thrust blocks have sufficiently hardened. Fill pipeline 24-hrs prior to testing, and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than 200 psi for 2 hours.

1. This test shall be performed by the Contractor with his labor and equipment in the presence of the Engineer. No testing will proceed until all thrust blocks are cured or restraining devices installed. Cleam and flush all piping thoroughly prior to testing. During filling of water all air will be carefully permitted to escape through release cocks installed as required.

$$\frac{L = (N)\ (D)\ (P)^{1/2}}{3700}$$ = allowable leakage in gallons per 2 hour test.

L = 0.00331 ND; for 150 psi test for 2 hours.
N = Number of joints in the section tested.

D = Nominal pipe diameter in inches.

P = Average test pressure maintained during the leakage test psig (gauge).

2. During the two (2) hour period of the test, the Contractor shall maintain a continuous pressure of 200 psi, by means of a pump taking supply from a container suitable for the measurement of water loss. Should the test fail, the leak will be located and repaired and the test performed again until it meets the above specified limits.

3. Inspection of Work: All work is subject to inspection by the Water Purveyor, Owner and Engineer. The following phases of construction shall be inspected by the Owner and Engineer:

   a. Placing of pipe, fittings and appurtenances. Hydrostatic Test.

3.6 ADJUSTING AND CLEANING

A. Flushing: Flush underground mains and lead-in connections to sprinkler risers before connection is made to sprinklers, standpipes, or other fire protection system piping.

1. Flush at flow rate not less than that indicated in NFPA 24, or at hydraulically calculated water demand rate of the system, whichever is greater.

END OF SECTION

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SECTION 31 27 20 - STORM SEWAGE SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. Extent of storm sewage systems work is indicated on drawings and schedules, and by requirements of this section.

B. Refer to Section 31 22 10 "EARTHWORK/UNDERGROUND UTILITIES" for excavation and backfill required for storm sewage systems; not work of this section.

C. Refer to Division-3 sections for concrete work required for storm sewage systems; not work of this section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of storm sewage system's products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with storm sewage work similar to that required for project.

C. Codes and Standards:

1. Plumbing Code Compliance: Comply with applicable portions of Florida Department of Transportation Standard Specification, 1988 Edition, pertaining to selection and installation of storm sewage system's materials and products.

D. Environmental Compliance: Comply with applicable portions of applicable Water Management District and Local Stormwater Management Codes pertaining to storm sewage systems.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for storm sewage system materials and products.

B. Shop Drawings: Submit shop drawings for storm sewage systems, showing piping materials, size, locations, and inverts. Include details of underground structures, connections, and manholes. Show interface and spatial relationship between piping and proximate structures.

C. Record Drawings: At project closeout, submit record drawings of installed storm sewage piping and products, in accordance with requirements of Division-1.

D. Maintenance Data: Submit maintenance data and parts lists for storm sewage system materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual; in accordance with requirements of Division-1.

PART 2 - PRODUCTS

2.1 PIPES AND PIPE FITTINGS

A. General: Provide pipes of one of the following materials, of weight/class indicated. Provide pipe fittings and accessories of same material and weight/class as pipes, with joining method as indicated.

1. Cast-Iron Soil Pipe: ASTM A 74, hub and spigot ends, service weight unless otherwise indicated.
   a. Fittings: Cast-iron hub and spigot complying with ASTM A 74; lead/oakum caulked joints, or compression joints with rubber gaskets complying with ASTM C 564.
2. Reinforced Concrete Pipe: FDOT 941, Class III (of ASTM C76).
   a. Fittings: Reinforced concrete, same strength as adjoining pipe, tongue-and-groove gasketed joints complying with ASTM C 443.
   b. Rubber Gaskets: FDOT 942.
3. Polyvinyl Chloride (PVC) Sewer Pipe: ASTM D 3033, Type PSP, SDR 35; or ASTM D 3034, Type PSM, SDR 35.
   a. Fittings: PVC, ASTM D 3033 or D 3034, elastomeric joints complying with ASTM D 3212 using elastomeric seals complying with ASTM F 477.
4. Corrugated Steel Pipe and Pipe Arch: FDOT 943, bituminous coated both sides.
5. Corrugated Steel Pipe and Pipe Arch: Aluminum coated (Aluminized Type II): AASHTO M274 and AASHTO M36.
6. Coupling/Corrugated Steel Pipe and Pipe Arch: AASHTO M36 with rubber or neoprene gaskets, FDOT 430-8.1 (all pipe).
7. Corrugated Aluminum Pipe and Pipe Arch: AASHTO M196 and AASHTO M211.
8. Corrugated Aluminum Pipe with Perforations (360 degree): AASHTO M196 and M211, ASTM B 209 for Alloy Alclade 3004-H34.
9. Coupling/Corrugated Aluminum Pipe and Pipe Arch: AASHTO M196 and AASHTO M211 with asphaltic mastic sealant (performed plastic material), (all pipe).
10. Filter Fabric: Spun bound polypropylene, "TYPAR," as manufactured by DuPont, Style 3401.
11. Bituminous Coating: AASHTO M190.
12. Non-shrinking Mortar: Embeco 167 or approved equal.
13. Precast Circular Manholes: Precast reinforced concrete per ASTM C 487, except wall thickness shall be 1 inch per foot of inside diameter plus 1 inch but 5 inch minimum. All openings shall have minimum steel hoop of #4 wire. Cement shall be Portland Type II. Provide a 6-inch lip on the base.
14. Concrete: FDOT 345-2 (except no pozzolon), 4, 6, 9, 10, 11, 12 and 13. Class II or Class III with minimum 28 day compressive strengths of 3400 psi and 5000 psi, respectively. Use Type II Portland Cement.
15. Reinforcement: FDOT 415 (ASTM A615, Grade 60).
16. Curing: FDOT 925.
17. Brick: ASTM C 32, grade MC (hard brick).
18. Mortar: For brick sections of manholes mix one (1) part Portland Cement Type II and three (3) parts of sand per FDOT 902-2.2. For mortar plaster use one (1) part cement, two (2) parts sand.
19. Manhole Joint Sealer: Pre-formed plastic joint sealer per Federal Specification SS-S-00210 (GSA - PSS), "Ram-Nek" as manufactured by the K.T. Snyder Co., Inc., or approved equal, or Portland Cement mortar, 1/2 inch minimum thickness.
20. Manhole Frame & Cover: Gray cast iron per ASTM A 48, Class 30 without perforations and suitable for addition of cast iron or steel rings for upward adjustment of top. The word "STORM" shall be cast into the face of the cover equal to that shown in the Standard Detail Drawings in 1-1/2 to 2 inch letters raised flush with the top of the cover. Frame and cover shall be approved equal to U.S. Foundry and Manufacturing Corp. No. 430 (old No. 32 with Type G cover). Frames and covers shall have machine ground seats and have a coating of coal tar pitch varnish.

    Where prefabricated adjustable frames are called for in the Drawings, they shall be approved equal to U.S. Foundry No 560 (old No. 23 with Type G Cover) and comply with the above requirements.
21. Inlet Gratings and Frames: Structural steel, FDOT 425-3.2, U.S. Foundry or equal; Gray Cast Iron, FDOT 962-8.

22. Bitumastic: Koppers No. 300M, or approved equal.
23. Non-shrink Mortar: Embeco 167 or approved equal.
24. Forms: Forms shall be either wood or metal, externally secured and braced when feasible, substantial and unyielding, and of adequate strength to contain the concrete and the additional force of vibration consolidation without bulging between supports and without apparent deviation from neat lines, contours and shapes shown in the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE AND PIPE FITTINGS

A. General: Trench excavation and backfill, including sheeting and bracing dewatering, foundation and bedding and furnishing and disposal of materials shall be as specified in Section 31 22 10 of these Standard Specifications, "EARTHWORK- UNDERGROUND UTILITIES" with any additional requirements included herein.

B. Laying Pipe: Pipe shall be laid "in the dry" true to the lines and grades given with hubs upgrade and tongue fully inserted into the hub. Provide recesses at each joint as required to establish continuous loading conditions along the pipe barrel. Maintain a clean interior as the work progresses. Adequate filtering methods shall be provided to prevent flushing debris and sediment into any receiving waters.

C. Round Concrete Pipe: ASTM C443-85a. Seal all joints with round rubber gaskets. The gasket and the surface of the joints must be clean and free of grit, dirt and other foreign matter. To facilitate closure of the joint, apply a vegetable soap lubricant immediately prior to closing. Do not apply mortar, joint compound, or other filler which will restrict the flexibility of the gasket joint.

Deviations from true alignment or grade, which result in a displacement from the normal position of the gasket of as much as 1/4 inch, or which produce a gap exceeding 1/2 inch between sections of pipe for more than 1/3 of the circumference of the inside of the pipe, will not be acceptable and where such occur the pipe shall be re-laid without additional compensation. Where minor imperfections cause a gap greater than 1/2 inch between pipe sections, the joint will be acceptable provided the gap does not extend more than 1/3 the circumference of the inside of the pipe.

D. Oval Concrete Pipe: Seal all joints with round rubber gaskets. The gasket and the surface of the joints must be clean and free of grit, dirt and other foreign matter. To facilitate closure of the joint, apply a vegetable soap lubricant immediately prior to closing. Do not apply mortar, joint compound, or other filler which will restrict the flexibility of the gasket joint.

E. Corrugated Steel Pipe: Field joint corrugated steel pipe with locking steel bituminous coated bands and rubber or neoprene gaskets to secure a water-tight joint. The gaskets shall be at least 7 inches in width and at least 3/8 inches thick, or 0-ring gaskets with a minimum chord diameter of 13/16 inch, with annular ends. A vegetable soap lubricant is acceptable to facilitate the field connection. A minimum of 10-1/2 inch bandwidth shall be provided.

F. Corrugated Aluminum Pipe: Make field joints with aluminum bands and asphaltic mastic gasket to secure a watertight joint. Band width shall be a minimum of 7 inches for 6 - 30 inch diameter and 12 inches for 36 - 60 inch diameter pipes.

G. Cast-Iron Soil Pipe: Install in accordance with applicable provisions of CISPI "Cast Iron Soil Pipe & Fittings Handbook."

H. Plastic Pipe: Install in accordance with manufacturer's installation recommendations, and in accordance with ASTM D 2321.

I. Cleaning Piping: Clear interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed.
1. In large, accessible piping, brushes and brooms may be used for cleaning.
2. Place plugs in ends of uncompleted conduit at end of day or whenever work stops.
3. Flush lines between manholes if required to remove collected debris.

J. Joint Adapters: Make joints between different types of pipe with standard manufactured adapters and fittings intended for that purpose.

K. Closing Abandoned Utilities: Close open ends of abandoned underground utilities which are indicated to remain in place. Provide sufficiently strong closures to withstand hydro-static or earth pressure which may result after ends of abandoned utilities have been closed.
1. Close open ends of concrete or masonry utilities with not less than 8 inches thick brick masonry bulkheads.

L. Interior Inspection: Inspect piping to determine whether line displacement or other damage has occurred.
1. Make inspections after lines between manholes, or manhole locations, have been installed and approximately 2 feet of backfill is in place, and again at completion of project.
2. If inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, correct such defects, and reinspect.

3.2 STORM SEWER STRUCTURES

A. Fabrication: All structures shall be constructed as shown in the Drawings or Standard Detail Indexes per FDOT Roadway and Bridge Design Standards. Structures may be precast concrete or poured in place concrete.

B. Foundation: Compact the soil beneath the structure to 95 percent of maximum (AASHTO T-180) density. Additionally provide 9 inches of gravel beneath structures with precast bases.

C. Manhole Base: Construct per Standard Detail Drawings with Type II Portland Cement concrete, Class II or cast as an integral part of the precast section. If the base is poured, form a groove in the base with an accurate manhole ring, shape with a wood float and finish with a hard steel trowel prior to setting. The base shall set a minimum of 24 hours before the manhole construction proceeds. Precast base shall have a minimum of three lifting hooks set in. The base shall extend 6 inches on all sides of the structure.

D. Joints - Precast Structures: Structures without precast integral bottoms shall be set in a bed of mortar to make a watertight joint at the base. Join precast sections with a minimum mortar thickness of 1/2 inch, maximum of 1 inch. Joint sealer may be used as an alternate.

E. Poured-in-place Concrete Structures: Concrete shall not be placed in any form until the reinforcing steel has been inspected and approved. Place concrete as noted in the Drawings and vibrate thoroughly. Fill each part of the forms, work the course aggregate back from the face and force the concrete under and around the reinforcing bars without displacing them from proper position. Place the concrete in approximately 12 inch lifts so as not to induce separation or segregation of the aggregates, consolidate thoroughly before preceding onward continuously so that there will be no plain separation between layers. Provide construction joints in accordance with the Drawings. Rub all exposed surfaces smooth to a point 12 inches below the proposed finished grade. All slabs open to traffic will be broom finished.

F. Curing: Cure continuously for a period of at least 72 hours, to commence after the finishing has been completed and as soon as the concrete has hardened sufficiently to permit application of the curing material without marring the surface. Curing may be accomplished by means of polyethylene covering, membrane curing compound, or wet-burlap. These methods shall initiate after the forms are removed and as outlined below:

1. Burlap. Place burlap over the entire surface of the concrete with overlap of approximately 6 inches along each edge and in contact with the entire surface.
2. Membrane Curing Compound. Apply membrane compound (clear or white) in one continuous uniform coating at a rate of one gallon per 200 square feet of area. Immediately recoat any crack or other defects appearing in the coating. Agitate the compound prior to application as well as during to prevent settlement of the pigment.
3. Polyethylene Sheeting. Place polyethylene sheeting over the entire surface with sufficient overlap of approximately 6 inches along the sides. Sheeting should be in continuous contact with the concrete at all times.

G. Manhole Invert: shape invert channels to a trowel finish conforming to the sizes and shapes of the lower 0.8 diameter of the inlets and outlets called for in the Drawings. changes in direction of the sewer and entering branch or branches shall have a true curve, with a centerline radius of at least three times the pipe diameter or channel width. Straight-through channels may be formed with pre-cut half pipes.

H. Manhole Coating: Coat the exterior surface with one coat of bitumastic at a minimum rate of 375 square feet per gallon, factory applied and "touched-up" in the field.

I. Manhole Frames and Covers: Set manhole frames and covers to conform to the grades in the Drawings. Set all frames securely in a cement mortar bed and fillet. All covers shall be made flush with existing permanent surfaces except outside the limits of the traveled ways where they should be set approximately 0.2 foot above the existing ground unless otherwise noted in the Drawings.

J. Manholes Watertightness: When tested by plugging all inlets and the outlet and filling the structure to within one foot of the cone section or top, with a minimum depth of 4 feet and maximum depth of 20 feet, the maximum allowable drop of the water surface shall be 1/2 inch per 15 minute interval. Contractor shall plug all leaks by method approved by the Engineer.

K. Pipe Connections: Seal pipes into structure openings with non-shrinking mortar. Provide one joint immediately outside the structure wall. Openings into existing structures shall be cut with a power driven abrasive wheel or saw.

3.3 BACKFILLING

A. General: Conduct backfill operations of open cut trenches closely following laying, jointing, and bedding of pipe, and after initial inspection and testing are completed.

3.4 FIELD QUALITY CONTROL

A. Lamping: Lamp all sewers between manholes, and catch basins after the backfill has been compacted to determine that they are clear of debris and to the correct alignment. The concentricity of the lamp image received shall not vary in the vertical direction but may vary up to 20 percent in the horizontal direction.

B. Inspection: Final visual inspection shall be made after all structures are raised to finished grade and the roadway installed. If the lines are unclean, clean-up and re-lamping shall be initiated. Contractor shall assist the engineer during this inspection.

END OF SECTION

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SECTION 31 27 30 - SANITARY SEWAGE SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. Extent of Sanitary sewage systems work is indicated on drawings and schedules, and by requirements of this section.

B. Refer to section 31 22 10 "Earthwork - Underground Utilities" for excavation and backfill required for sanitary sewage systems; not work of this section.

C. Refer to Division-3 sections for concrete work required for sanitary sewage systems; not work of this section.

D. Refer to Division-22 for interior building wastewater systems including drain, waste, and vent piping; not work of this section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of sanitary sewage system's products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with sanitary sewage work similar to that required for project.

C. Codes and Standards:

1. Plumbing Code Compliance: Comply with applicable portions of National Standard Plumbing Code pertaining to selection and installation of sanitary sewage system materials and products.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for sewage system materials and products.

B. Shop Drawings: Submit shop drawings for sanitary sewage systems, showing piping materials, size, locations, and inverts. Include details of underground structures,

connections, and cleanouts. Show interface and spatial relationship between piping and proximate structures.

C. Record Drawings: At project closeout, submit record drawings of installed sanitary sewage piping and products, in accordance with requirements of Division-1.

D. Maintenance Data: Submit maintenance data and parts lists for sewage system materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual; in accordance with requirements of Division-1.

PART 2 - PRODUCTS

2.1 IDENTIFICATION

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

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering identification markers which may be incorporated in the work include, but are not limited to, the following:

a. Allen Systems, Inc.
b. Emed Co., Inc.
c. Seton Name Plate Corp.

2.2 PIPES AND PIPE FITTINGS

A. Polyvinyl Chloride Pipe & Fittings (PVC): Pipe and fittings, ASTM D3034, SDR 35 and shall have integrally formed bell and spigot with factory installed rubber sealing ring gaskets. Pipe shall be in maximum laying length of 12.5 feet. Joints, ASTM D3212, push-on type elastomeric compression gaskets. Field solvent weld joints are not acceptable. PVC materials shall be approved equal to "Ring-Tite" as manufactured by Johns-Manville.

B. Ductile Iron Pipe & Fitting (DI): Pipe shall be ductile iron (DI) with minimum thickness of Class 51 for 3 and 4 inch and Class 50 for larger pipe. ANSI 21.51 (AWWA C151); Fittings, ANSI 21.10 (AWWA C110); Joints, ANSI 21.11 (AWWA C111).

C. Gray Iron Pipe & Fittings (GI): Pipe, ANSI 21.6 (AWWA C106); Fittings, ANSI 21.10 (AWWA C110); Joints, ANSI 21.11 (AWWA C111).

D. Pipe Coupling & Bushing Adapter: Rubber couplings with stainless steel ring clamps at both ends and stainless steel shear ring and rubber bushings as required, approved equal to Mission Rubber Company, Inc.

E. PVC - Manhole Connector: Asbestos-cement manhole adapter, approved equal to Johns-Manville.

F. Non-shrink Mortar: Embeco 167 or approved equal.

G. Precast Manholes: Precast reinforced concrete per ASTM C478, except wall thickness shall be 1 inch per foot of inside diameter plus 1 inch but 5 inch minimum. All openings shall have minimum steel hoop of #4 wire. Cement shall be Portland Type II. Manholes shall be in accordance with the Standard Detail Drawings.

H. Concrete: FDOT 345-2 (except no pozzolan), 4, 6, 9, 10, 11, 12 and 13. Class I, Class II, and Class III shall have minimum 28 day compressive strengths of 2500 psi, 4000 psi, and 5000 psi, respectively.

I. Reinforcement: FDOT 415

J. Curing: FDOT 925

K. Brick: ASTM C32, grade MC (hard brick).

L. Mortar: For brick sections of manholes mix one (1) part Portland Cement Type II and three (3) parts of sand per FDOT 902-2.2. For Mortar plaster use one (1) part cement, two (2) parts sand.

M. Manhole Joint Sealer: Pre-formed plastic joint sealer per Federal Specification SS-S-00210 (GSA-PSS), "Ram-Nek" as manufactured by the K.T. Snyder Col, Inc., or approved equal.

N. Manhole Frame & Cover: Gray cast iron per ASTM A48, Class 30 without perforations and suitable for addition of cast iron or steel rings for upward adjustment of top. The word "SANITARY" shall be cast into the face of the cover equal to that shown in the Standard Detail drawings in 1 1/2 to 2 inch letters raised flush with the top of the cover. Frame and cover shall be approved equal to U.S. Foundry and Manufacturing Corp. No. 430 (old No. 32 with Type G cover). Frames and covers shall have machine ground seats and have a coating of coal tar pitch varnish.

Where prefabricated adjustable frames are called for the Drawings, they shall be approved equal to U.S. Foundry No. 560 (old No. 23 with Type G cover) and comply with the above requirements.

Where manholes are subjected to periodic flooding or lie within the 100 year flood plain, or as designated by the Engineer, frames and covers shall be made watertight by means of gaskets and bolted covers approved equal to U.S. Foundry.

O. Bitumastic: Koppers No. 300M, or approved equal.

P. Bedding Material: Bedding materials shall be as specified in Section 02210 of these Standard Specifications, "Earthwork - Underground Utilities".

PART 3 - EXECUTION

3.1 INSTALLATION OF IDENTIFICATION

A. General: During back-filling/top-soiling of sanitary sewage systems, install continuous underground-type plastic line marker, located directly over buried line at 24 inches below finished grade.

3.2 INSTALLATION OF PIPE AND FITTINGS

A. Pipe Laying & Jointing: Lay pipe with spigot ends pointing in the direction of flow starting at the lowest point. Clean joint contact surfaces immediately prior to jointing. Use lubricants, primers and adhesives as recommended by the joint manufacturer.

B. Branches: Wye branches are to be installed in conjunction with the laying of the sewer pipe. Install wyes to serve all existing and future dwelling units, as noted in the Drawings. The longitudinal barrel of branch fittings shall conform to the line and grade, diameter, and quality of the sewer main. All service laterals shall be perpendicular to the longitudinal axis of the pipe.

C. Laterals: Install service laterals and wye branch fittings as shown in the Standard Detail Drawings and as sized and located in the Drawings. Laterals shall be located between 3 feet minimum and 5 feet maximum below right-of-way finished grade at the service. Laterals shall be run perpendicular to the sewer main at a minimum grade of 1 percent from the main to the right-of-way line. Provide a wye branch fitting for each service lateral; double wyes are not acceptable. Plug all laterals and service wyes at the last joint and securely seal to withstand the internal pressure of leakage or air pressure testing, but the plug shall also be capable of removal without injury to the socket. Chisel an "S" in the top of the curb directly over the lateral location. If curbing is not part of the work, install a 4" x 4" X 3'0" wooden stake at the end of the connection.

D. Transition Connections: Where pipes of different materials are to be connected between manholes, suitable transition couplings shall be installed. Couplings as cited herein are the only acceptable materials.

E. Connections to Existing Lines: Use a collar wye saddle for 4 inch and 6 inch diameter connections into existing sewer lines. The existing line shall be cut using a template to accomplish a true and clean opening for the saddle. Gasketed saddles with stainless steel straps shall be used where available from the manufacturer. The sewer main shall be protected and cleaned of debris.

F. Chimney Connections: Provide chimney connections, as shown in the Standard Detail Drawings where the depth of sewer main invert exceeds 10 feet below the finished grade of the street, unless otherwise required by the Engineer. One chimney may only serve 4 connections -double to each side or less. Chimney shall be encased in Class I Concrete.

G. Connections to Manholes: Connections shall be in accordance with the Standard Detail Drawings. PVC connections shall be made using an asbestos-cement adapter pre-cast or mortared into the structure. Clay pipe and iron pipe (and asbestos-cement adapters when mortared) shall be mortared into structures with non-shrinking mortar applied and cured in strict conformance with manufacturer's recommendations such that no leakage through the annular joint occurs. Finish mortar smooth and flush with the adjoining interior and exterior wall surfaces. Clay pipe shall have a short nipple (18 inch or 24 inch) between the manhole fitting and the first full length of pipe. All openings for pipes into existing structures shall be made by cutting with a power driven abrasive wheel or saw.

H. Connections to Wet wells: Provide one (1) joint (18 - 20 feet) of ductile iron pipe to extend outward from the structure. Mortar the connections as per above.

I. Conflicting Structures: Where it becomes necessary to extend sewers through structures, such as conflicting manholes, junction boxes, etc., the pipe within shall be ductile iron with no joints inside the conflicting structure.

J. Manholes: Manholes shall be in accordance with the Standard Detail Drawings. Manholes shall be precast with integral slab and lower ring, or poured in place slab with precast ring wall or mortared brick wall construction. All manholes shall have bitumastic coating as specified herein.

Brick manholes shall be true and symmetric with all courses level. Bricks shall be placed by shoving into a full bed of mortar with 1/4 to 1/2 inch joints completely filled. Courses shall be laid continuously with alternating joints and with whole headers every sixth course. Excess mortar shall be carefully struck off. Portland cement plaster (1/2 inch minimum) shall be applied to the interior and exterior brick surfaces. Brick manholes shall be protected and kept moist for at least 48 hours following completion during hot or dry weather.

K. Manhole Foundation: Compact the soil beneath the manhole to 95% of maximum (AASHTO T-180) density. Additionally provide 9 inches of gravel beneath precast manhole bases.

L. Manhole Base: Poured in place with Type II Portland cement concrete per Standard Detail Drawings or cast as an integral part of the precast section. If the base is poured, from a groove in the base with an accurate manhole ring, shape with a wood float and finish with a hard steel trowel prior to setting. The base shall set a minimum of 24 hours before the manhole construction proceeds. Precast base shall have a minimum of three lifting hooks set in and shall have a 6-inch lip.

M. Manhole Invert: Shape invert channels to a trowel finish conforming to the sizes and shapes of the lower 0.8 diameter of the inlets and outlets called for in the Drawings. Changes in direction of the sewer and entering branch or branches shall have a true curve, with a centerline radius of at least three times the pipe diameter or channel width. Straight-through channels may be formed with pre-cut half pipes.

N. Manhole Coating: Two (2) coats of bitumastic applied to the internal surfaces at a minimum rate of 120 square feet per gallon per coat and one coat to external surfaces at a minimum rate of 375 square feet per gallon.
External surfaces shall be pre-painted. Internal surfaces shall be painted in the field after installation and after inspection.

O. Top Elevation: Adjust precast manhole top between 6 inches and 12 inches by means of precast concrete rings or bricks laid in mortar.

P. Manhole Frames and Covers: Set manhole frames and covers to conform to the grades in the Drawings. Set all frames securely in a cement mortar bed and fillet. All covers shall be made flush with existing permanent surfaces except outside the limits of the traveled ways where they should be set approximately 0.2 foot above the existing ground unless otherwise noted in the Drawings.

Q. Stubs and Stoppers: Install pipe stoppers to all manhole stubs noted in the Drawings. When connecting to an existing stub, prior to removing the existing stopper, brick the inside opening to prevent any flow until the new system has been tested and cleaned. The brick shall not be removed until final inspection.

R. Bulkheading Stub Channels: Bulkhead the downstream end of all outlets in the manholes of stub-out-channels not in use, to prevent the creation of a septic condition resulting from ponding of sewage or debris up the used channel.

S. Protection of Water System at Crossings: Where the location of the sewer is not clearly defined by dimensions on the drawings, the sewer shall not be laid closer horizontally than 10 feet to a water main or service line. Pressure sewer lines shall only pass beneath water lines, with the top of the sewer line being at least 2 feet below bottom of water line. Where sanitary sewer lines pass above water lines, the sewer shall be encased in concrete for a distance of 10 feet on each side of the crossing, or rubber-gasketed pressure pipe shall be substituted for the pipe being used for the same distance. Where sanitary sewer lines pass below water lines, no joint in the sewer line shall be closer that 3 feet, horizontal distance, to the water line. Each pipe shall be carefully inspected before and after it is installed and defective pipe shall be rejected. Proper facilities shall be provided for lowering sections of pipe into trenches.

T. Downstream Protection: Pipe shall not be flushed downstream. Open end of pipe shall be closed daily to prevent foreign matter from entering.

U. PVC Ring Deflection: Maximum diametric ring deflection shall not exceed 5 percent of the internal pipe diameter throughout the warranty period when tested by a mandrel.

3.3 FIELD QUALITY CONTROL

A. Testing - Low Pressure Air Leakage: All sanitary sewers shall be tested by means of a low pressure air leakage test. When tested by this method, the pipe is first pressure stabilized at 4 psig greater than the average groundwater back-pressure: Subsequent leakage shall not exceed the following:

0.0015 cubic feet per minute per square foot for PVC.
0.0030 cubic feet per minute per square foot for VCP.

B. Testing - Infiltration or Exfiltration: If approved by Engineer, infiltration or exfiltration test may be performed in lieu of the air pressure test. When tested a minimum of three (3) days after the cessation of dewatering, the maximum allowable leakage shall not exceed the following rates per mile of main line (not laterals):

50 gallons per day per nominal inch for PVC
100 gallons per day per nominal inch for VCP

C. Testing - Manhole Watertightness: Contractor shall test manhole watertightness by plugging all inlets and the outlet and filling the manhole to within one foot of the cone section. With a minimum depth of 4 feet and maximum depth of 20 feet, the maximum allowable drop of the water surface shall be 1/2 inch per 15 minute interval. Contractor shall plug all leaks by method approved by Engineer.

D. Lamping: Contractor shall lamp between manholes. The concentricity at the lamp image received shall be such that the diameter of said image shall have no vertical reduction from that of the pipe inside diameter and not more than 20 percent horizontal reduction.

E. Resurfacing: All test shall be completed and accepted by Engineer before any trench or pavement is surfaced/resurfaced.

F. Final Inspection: After all manholes are raised to grade and paving operations completed, a final visual inspection will be made. Contractor shall assist the engineer by providing labor as required. Additional lamping may be required if it appears that lines are unclean. Contractor will be present to note required corrections, if any, and schedule their remedial action immediately before the work is accepted.

END OF SECTION 31 27 30

SECTION 31 28 31 - CHAIN LINK FENCING AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. Extent of chain link fences and gates is indicated on drawings.

1.3 QUALITY ASSURANCE

A. Provide chain link fences and gates as complete units controlled by a single source including necessary erection accessories, fittings, and fastenings.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical data, and installation instructions for metal fencing, fabric, gates and accessories.

PART 2 - PRODUCTS

2.1 GENERAL

A. Dimensions indicated for pipe, roll-formed, and H-sections are outside dimensions, exclusive of coatings.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Galvanized Steel Fencing and Fabric:
    a. Allied Tube and Conduit Corp.
    b. American Fence Corp.
    c. Anchor Fence, Inc.
2. Aluminized Steel Fencing and Fabric:
    a. Page Fence Div./Page-Wilson Corp.
    b. Cyclone Fence/United States Steel Corp.
    c. or approved equal
3. Aluminum Fencing and Fabric:
    a. Chain Link Fence Company of Pennsylvania.
    b. Security Fabricators, Inc.
    c. or approved equal
4. Barbed Type:
    a. American Fence Corp.
    b. Man Barrier Corp.
    c. Or equal

2.2 STEEL FABRIC

A. Fabric: No. 9 ga. Core wire (0.148" + 0.005") size steel wires, 2" mesh, with top selvages knuckled for fabric 60" high and under, and both top and bottom selvages twisted and barbed for fabric over 60" high. Vinyl Coating shall be class 2b thermally fused & bonded per ASTM 668.

1. Furnish one-piece fabric widths for fencing up to 12' high.

2. Fabric Finish: Galvanized, ASTM A 392, Class II, with not less than 2.0 oz. zinc per sq. ft. of surface.

3. Fabric Finish: Aluminized, ASTM A 491, Class II, with not less than 0.40 oz. aluminum per sq. ft. of surface.

2.3 FRAMING AND ACCESSORIES

A. Steel Framework, General: Galvanized steel, ASTM A 120 or A 123, with not less than 1.8 oz. zinc per sq. ft. of surface.

1. Fittings and Accessories: Galvanized, ASTM A 153, with zinc weights per Table I.

B. End, Corner and Pull Posts: Minimum sizes and weights as follows:

1. Up to 6' fabric height, 2.375" OD steel pipe, 3.65 lbs. per lin. ft., 3.5" x 3.5" roll-formed sections, 4.85 lbs. per lin. ft.

2. Over 6' fabric height, 2.875" OD steel pipe, 5.79 lbs. per lin. ft., or 3.5" x 3.5" roll-formed sections, 4.85 lbs. per lin. ft.

C. Line Posts: Space 10' o.c. maximum, unless otherwise indicated, of following minimum sizes and weights.

1. Up to 6' fabric height, 1.90" OD steel pipe, 2.70 lbs. per lin. ft. or 1.875" x 1.625" C-sections, 2.28 lbs. per lin. ft.

2. 6' to 8' fabric height, 2.375" OD steel pipe, 3.65 lbs. per lin. ft. or 2.25" x 1.875" H-sections, 2.64 lbs. per lin. ft.

3. Over 8' fabric height, 2.875" OD steel pipe, 5.79 lbs. per lin. ft. or 2.25" x 1.875" H-sections, 3.26 lbs. per lin. ft.

D. Gate Posts: Furnish posts for supporting single gate leaf, or one leaf of a double gate installation, for nominal gate widths as follows:

1.

Leaf Width	Gate Post	lbs./lin. ft.
Up to 6'	3.5" x 3.5" roll-formed	4.85
	section or 2.875" OD pipe	5.79
Over 6' to 13'	4.000" OD pipe	9.11
Over 13' to 18'	6.625" OD pipe	18.97
Over 18'	8.625" OD pipe	28.55

E. Top Rail: Manufacturer's longest lengths, with expansion type couplings, approximately 6" long, for each joint. Provide means for attaching top rail securely to each gate corner, pull and end post.

1. 1.66" OD pipe, 2.27 lbs. per ft. or 1.625" x 1.25" roll-formed sections, 1.35 lbs. per ft.

F. Tension Wire: 7-gage, coated coil spring wire, metal and finish to match fabric.

1. Locate at bottom of fabric.

G. Wire Ties: 11 ga. galvanized steel or 11 ga. aluminum wire, to match fabric core material.

H. Post Brace Assembly: Manufacturer's standard adjustable brace at end and gate posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Use same material as top rail for brace, and truss to line posts with 0.375" diameter rod and adjustable tightener.

I. Post Tops: Provide weathertight closure cap with loop to receive tension wire or toprail; one cap for each post.

J. Stretcher Bars: One-piece lengths equal to full height of fabric, with minimum cross-section of 3/16" x 3/4". Provide one stretcher bar for each gate and end post, and 2 for each corner and pull post, except where fabric is integrally woven into post.

K. Stretcher Bars Bands: Space not over 15" o.c., to secure stretcher bars to end, corner, pull, and gate posts.

L. Barbed Wire Supporting Arms: Manufacturer's standard barbed wire supporting arms, metal and finish to match fence framework, with provision for anchorage to posts and attaching 3 rows of barbed wire to each arm. Supporting arms may be either attached to posts or integral with post top weather cap and must be capable of withstanding 250 lbs. downward pull at outermost end. Provide following type:

1. Single 45 deg. arm; for 3 strands barbed wire, one for each post.

M. Barbed Wire: 2 strand, 12-1/2 ga. wire with 14 ga. 4-point barbs spaced not more than 5" o.c., metal and finish to match fabric.

N. Barbed Tape: Continuous helical coils of barbed stainless steel tape, fabricated from .025" thick x 1" wide austenitic stainless steel with 4 needle sharp barbs on 4" centers and permanently clenched to .098" diameter core wire of high tensile zinc-coated steel. Adjacent loops clipped together to limit extension of coil. Provide coil diameter, type and configuration as indicated; if not otherwise indicated, provide 24" diameter, single concertina type coil.

2.4 GATES

A. Fabrication: Fabricate perimeter frames of gates from metal and finish to match fence framework. Assemble gate frames by welding or with special fittings and rivets, for rigid connections, providing security against removal or breakage connections. Provide horizontal and vertical members to ensure proper gate operation and attachment of fabric, hardware and accessories. Space frame members maximum of 8' apart unless otherwise indicated.

1. Provide same fabric as for fence, unless otherwise indicated. Install fabric with stretcher bars at vertical edges and at top and bottom edges. Attach stretchers bars to gate frame at not more than 15" o.c.

2. Install diagonal cross-bracing consisting of 3/8" diameter adjustable length truss rods on

gates to ensure frame rigidity without sag or twist.

3. Where barbed wire is indicated above gates, extend end members of gate frames 1'-0" above to member and prepare to receive 3 strands of wire. Provide necessary clips for securing wire to extensions.

B. Swing Gates: Fabricate perimeter frames of minimum 1.90" OD pipe.

C. Gate Hardware: Provide hardware and accessories for each gate, galvanized per ASTM A 153, and in accordance with the following:

1. Hinges: Size and material to suit gate size, non-lift-off type, offset to permit 180 deg. gate opening. Provide 1-1/2 pair of hinges for each leaf over 6' nominal height.

2. Latch: Forked type or plunger-bar type to permit operation from either side of gate, with padlock eye as integral part of latch.

3. Keeper: Provide keeper for vehicle gates, which automatically engages gate leaf and holds it in open position until manually released.

4. Double Gates: Provide gate stops for double gates, consisting of mushroom type flush plate with anchors, set in concrete, and designed to engage center drop rod or plunger bar. Include locking device and padlock eyes as integral part of latch, permitting both gate leaves to be locked with single padlock.

D. Sliding Gates: Provide manufacturer's standard heavy-duty inverted channel track, ball-bearing hanger sheaves, overhead framing and supports, guides, stays, bracing, hardware, and accessories as required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Do not begin installation and erection before final grading is completed, unless otherwise permitted.

B. Excavation: Drill or hand excavate (using post hole digger) holes for posts to diameters and spacings indicated, in firm, undistributed or compacted soil.

1. If not indicated on drawings, excavate holes for each post to minimum diameters as recommended by fence manufacturer, but not less than 4 times largest cross-section of post.

2. Unless otherwise indicated, excavate hole depths approximately 3" lower than post bottom, with bottom of posts set not less than 36" below finish grade surface.

C. Setting Posts: Center and align posts in holes 3" above bottom of excavation.

1. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.

a. Unless otherwise indicated, extend concrete footings 2" above grade and trowel to a crown to shed water.

D. Top Rails: Run rail continuously through post caps, bending to radius for curved runs. Provide expansion couplings as recommended by fencing manufacturer.

E. Center Rails: Provide center rails where indicated. Install in one piece between posts and flush with post on fabric side, using special offset fittings where necessary.

F. Brace Assemblies: Install braces so posts are plumb when diagonal rod is under proper tension.

G. Tension Wire: Install tension wires through post cap loops before stretching fabric and tie to each post cap with not less than 6 ga. galvanized wire. Fasten fabric to tension wire using 11 ga. galvanized steel hog rings spaced 24" o.c.

H. Fabric: Leave approximately 2" between finish grade and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Install fabric on security side of fence, and anchor to framework so that fabric remains in tension after pulling force is released.

I. Stretcher Bars: Thread through or clamp to fabric 4" o.c., and secure to posts with metal bands spaced 15" o.c.

J. Barbed Wire: Pull wire taut and install securely to extension arms and secure to end post or terminal arms in accordance with manufacturer's instructions.

K. Barbed Tape: Install barbed tape in configurations indicated in accordance with manufacturer's recommendations and securely fasten to fencing to prevent movement or displacement.

L. Gates: Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

M. Tie Wires: Use U-shaped wire, conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least 2 full turns. Bend ends of wire to minimize hazard to persons or clothing.

1. Tie fabric to line posts, with wire ties spaced 12" o.c. Tie fabric to rails and braces, with wire ties spaced 24" o.c. Tie fabric to tension wires, with hog rings spaced 24" o.c.

N. Fasteners: Install nuts for tension bands and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

END OF SECTION

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SECTION 31 29 20 - SEWAGE LIFT STATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions apply to this section.

1.2 DESCRIPTION OF WORK

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

B. Refer to section 31 22 10 "Earthwork - Underground Utilities" for excavation and backfill required for sanitary sewage systems; not work of this section.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of pumping system's products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with sanitary sewage work similar to that required for project.

C. Codes and Standards:

1. Code Compliance: Comply with applicable portions of Florida Department of Environmental Regulation and Orange County Public Utilities.

1.4 SUBMITTALS

A. Shop Drawings: Wiring diagrams for all equipment showing full details of factory wiring and all field wiring required to complete installation and pump pit.

B. Product Data: Manufacturer's detailed literature, including equipment capacity data:

1. Pumps complete with required accessories.
2. Controls and control panels.
3. Valves (all types).
4. Flange gaskets.
5. Corrosion protection materials.
6. Pit access covers.

C. Certificates of Compliance:

1. Certifications: Manufacturer's detailed literature that notes compliance with reference standards (including types, pressure rating, schedule, class and grade.
2. Manufacturer's detailed literature:
   a. Pipe.
   b. Pipe fittings.
   c. Pipe flanges.
3. Record drawings:
   a. Pipe.
   b. Pipe fittings.
   c. Pipe flanges.
4. Maintenance Data:
   a. Pipe.
   b. Pipe fittings.
   c. Pipe flanges.

PART 2 - PRODUCTS

2.1 GENERAL

A. Pipes, pipe fittings, plug valves, and check valves shall be per Orange County Utilities Standards and Specifications, Latest Edition.

2.2 PRE-CAST WET WELL SECTIONS

A. ASTM C478 as modified in Section 31 27 30 of Standard Specifications, for "Sanitary Sewage Systems."

2.3 PUMPS AND MOTORS

A. Hydromatic, Flygt, or approved equal, 3 phase, 240 volt.

2.4 DISCHARGE ELBOW/ANCHOR BOLTS

A. Class 125, flanged, per pump manufacturer.

2.5 ACCESS FRAMES AND COVERS

A. Aluminum, sized to provide access clearance as required by the pump manufacturer, and as required to adequately service and/or remove check valves from the check valve vault. Cover shall have lifting handles, safety latches and locking hasp.

2.6 CONTROL EQUIPMENT

A. As listed below or approved equal:

1. Enclosure - Weatherproof, NEMA-3R with dead front panel, separate removable inside panel, handle and lock hasp.
2. Main Disconnect - Two manual interlocked circuit breakers.
3. Starters.
4. Alternator - Plug-in type.
5. Bubbler Level Control - Air pump, Mercury tube type switches in Honeywell Vapor stat.
6. High-level Sensor - Normally open, mercury float ball.
7. High Level Alarm - 115 Volt AC light in weatherproof bracket fixture for 100 watt lamp with red enclosing PVC vapor tight globe.
8. Relays.
9. Elapsed Time Meters.
10. HOA Switches.
11. Lightning Arrester, 3 phase.
12. Phase Voltage Monitor Relay - Phase loss, phase reversal and low voltage sensor and relay to alarm system.
13. Run-lights - Red running lights.
14. Emergency Generator Plug - Russell & Stoll JRS 1033F for 0 to 5 HP and JRS 1044F for greater than 5 HP.
15. Pump Disagree Timer.
16. Convenience Outlet - Grounded type 115 Volt, 60 cycle.

2.7 VENT CAP

A. Vandal-proof, hooded, galvanized iron equal to Josam 26700.

2.8 BACKFLOW PREVENTER

A. Provide hose bib backflow prevention device conforming with requirements of the local authority.

2.9 CONCRETE

A. FDOT 345-2 (except no pozzolan), 3, 4, 6, 9, 10, 11, and 12. Class I and Class II shall have minimum compressive strength of 2500 and 3400 psi respectively.

2.10 REINFORCEMENT

A. FDOT 415.

2.11 CURING

A. FDOT 932.

2.12 FENCING

A. Refer to Section 02831 - Chain Link Fencing and Gates.

PART 3 - EXECUTION

3.1 GENERAL

A. Excavation and backfill including sheeting and bracing, dewatering, bedding and foundation, and furnishing and disposal of materials shall be as specified in Section 31 22 10 of these Standard Specifications, "Earthwork - Underground Utilities," with any additional requirements included herein.

3.2 WET WELLS

A. Construct wet wells to the same requirements as sanitary sewer manholes with the following additional requirements:

1. Base shall be monolithic with lower ring.
2. Base slab and top slab shall be constructed to the dimensions shown in the Standard Detail Drawings. Wall thickness and inside diameter of the wet well shall be constant over its full depth.
3. Brick construction shall not be acceptable.

3.3 PIPE, VALVES AND FITTINGS

A. All exposed pipe shall have flanged joints. All buried pipes shall have mechanical joints.

3.4 PUMP INSTALLATION

A. Install equipment in accordance with approved shop drawings and manufacturer's instructions to operate as intended by the manufacturer. Locate upper guide rail holders exactly as required to seat pumps such that shafts will turn freely without binding or leaking.

3.5 CONTROL PANEL

A. The control panel shall be factory assembled and tested prior to installation at the pump station. Contractor shall provide for coordination between pump manufacturer and panel manufacturer to assure that the control panel as a whole as well as the individual components comprise a system which is intimately compatible with the pumps. The following equipment shall be included in the panel: Main breakers, pump circuit breakers (2), 20 amp panel circuit breaker, bubbler control, pump, mercury vapor stat switches (2), starters (2), alternator, elapsed time meters (2), run lights (2), HOA switches (2), starters disagree timer, phase voltage monitor relay. All switches, main circuit wiring, breakers and other devices shall be clearly and neatly labeled inside the control panel. A single line wiring diagram shall be included within the panel with a copy provided for the Engineer's record.

3.6 HIGH LEVEL ALARM

A. Provide two mercury float ball switches as high level alarm switches to the telemetry system and to the red alarm signal light. Mount red alarm light on top of control panel enclosure.

3.7 ACCESSORY EQUIPMENT

A. Provide lightning arrester, emergency disconnect switch, emergency generator plug, red alarm light, bubbler piping and convenience outlet as shown in the Standard Detail Drawings.

3.8 POTABLE WATER SUPPLY

A. Provide 1-inch potable water service with 3/4 inch hose bib and backflow prevention device (B-9) to the station. Exposed pipe shall be galvanized iron.

3.9 GRADING

A. Grade the site away from the cover slab a 1 inch per foot drop.

3.10 FACTORY PERFORMANCE TESTS

A. Manufacturer's factory performance tests and certified performance curves shall be provided for capacity power requirement and efficiency at specified minimum operating head, rated head, shut-off head and at as many other points as necessary.

3.11 FIELD TESTING

A. Field testing shall be provided by Contractor with pump manufacturer's representative present and witnessed by the Engineer to provide a three point pump performance test by measuring amp draw and voltage, discharge pressure and rate of flow. Rate of flow and head must be within 10 percent and 5 percent respectively above the approved curve for acceptance. Results shall be provided to the Orange County Representative prior to final inspection of the system.

3.12 START-UP AND FINAL INSPECTION

A. Contractor shall schedule with the Orange County Representative and Engineer for start-up and final inspection at the completion of the work.

3.13 PUMP STATION ELECTRICAL POWER AND CONTROL SYSTEM

A. This section specifies the electrical power and control system requirements for wastewater pump stations. These requirements apply to duplex pump panels. Similar requirements shall apply when more than two pumps are involved except for the quantity of control equipment and panel size shall be increased accordingly. The manufacturer of the control panel shall provide data to indicate that the manufacturer has a minimum of 3 years experience in the building of pump control panels.

A pump station control panel shall be provided for each wastewater pump station. (See approved manufacturer's list in appendix.) The control panel shall respond to liquid level float switches to automatically start and stop pumps as well as sound an alarm upon high or low wet well levels. The control panel shall operate two (2) electrical submersible pumps at the power characteristics stipulated. The control function shall provide for the operation of the lead pump under normal conditions. If the incoming flow exceeds the pumping capacity of the lead pump, the lag pump shall automatically start to handle this increased flow. As the flow decreases, pumps shall be cut off at elevation as shown on the Plans. Pumps shall alternate positions as lead pump at the end of each cycle. A failure of the alternator shall not disable the pumping system. The alternator shall include a safe, convenient method of manual operation alternation without disturbing any wiring. Should the "pump off" regulator fail, the system shall keep the station in operation and provide a visual indication of the regulator failure.

The control panel shall consist of main circuit breakers and generator breaker with mechanical interlock, an emergency power receptacle, a circuit breaker and magnetic starter for each pump motor, and 15 ampere, 120 volt circuit breakers as required. All pump control operations shall be accomplished by a float type liquid level control system with all control components mounted in one common enclosure. Control switches shall provide means to operate each pump manually or automatically. When operated in the automatic mode, the control assembly shall provide means to manually select or automatically alternate the position of the "lead" and "lag" pumps after each pumping cycle. A float type liquid level control system shall continuously monitor wet well liquid level and control operation of the low-level cutoff for the pumps and shall operate off a 24 volt circuit.

B. Panel Construction

The duplex pump panel shall be housed in a NEMA 3R, Type 304, 14 Gauge stainless steel enclosure with 30% extra mounting space for additional equipment. Enclosure shall have provisions for padlocking the door and a dead front inner door unit for mounting controls. All exterior hardware and hinges shall be stainless steel.

There shall be permanently affixed to the interior side of the exterior enclosure door both a nameplate and a 10" x 12" pocket for log sheet storage. The nameplate shall contain the following information, voltage, phase, rated horsepower, speed, date manufactured and pump and control panel manufacturer's name, address and telephone number, pump data, including impeller data, operating point and head, KW input, and amps at the operating point and at least two other points on the pump curve.

The control panel and enclosure shall be Underwriters Laboratories (UL) 50 type 3R listed.

C. Power Supply and Main Disconnect

Power supply to the control panel shall be either 240 volt, 3 phase, 4 wire or 480 volt, 3 phase, 4 wire. Minimum service shall be 100 AMP. Single phase power shall not be accepted.

Nonfusible safety service main disconnects shall be installed at all stations. In all 240 volt systems, disconnects should be installed between the meter and the panel and on all 480 volt systems disconnect should be installed ahead of the meter. LED power available indicators shall be supplied on all legs.

D. Circuit Breakers

1. Main Breakers - The panel shall have an inter-lock system between the normal power main breaker and the emergency breaker to ensure only one breaker is in the "on" position at a time. Both breakers shall be equal in size. (See approved manufacturers' list in appendix.)

2. Circuit Breakers - All circuit breakers shall be heavy duty molded case breakers. The handle on the circuit breakers shall be operational through the inner door. (See approved manufacturers' list in appendix.

E. Motor Circuit Protectors

Each pump motor shall be protected by a 3-pole motor circuit protector. (See approved manufacturers' list in appendix.) The Motor Circuit Protector shall be operated by a toggle-type handle and shall have a quick-make, quick-break overcenter switching mechanism that is mechanically trip-free from the handle so that the contacts cannot be held closed against a short circuit and abnormal currents which cause the Motor Circuit Protector to trip. Tripping shall be clearly indicated by the handle automatically assuming a position midway between the normal ON and OFF positions. All latch surfaces shall be ground and polished. All poles shall be so constructed that they open, close, and trip simultaneously. Motor Circuit Protector must be completely enclosed in a high-strength glass polyester molded case. Ampere ratings shall be clearly visible. Contacts shall be of non-welding silver alloy. Arc extinction must be accomplished by means of arc chutes. A manual push-to-trip button shall be provided for manual exercising of the trip mechanism. Each pole of these Motor Circuit Protector's shall provide instantaneous short circuit protection by means of an adjustable magnetic-only element.

F. Motor Starter and Selector Switches

The panel shall contain two motor starters. The motor starter shall be across the line magnetic starter with individual overload protection on each power leg with reset installed through the inner door unit. (See approved manufacturers' list in appendix.) Local Power Company Regulations shall govern.

G. Pump Alternator

An eight pin plug-in solid state alternator (see approved manufacturers' list in appendix) shall be provided to change the pump starting sequence on each pumping cycle. A three position alternator test switch shall be provided to control the alternation operation. Switch positions to include the "Auto" to provide normal automatic sequence, "Off" position to disable alternator, and "test" position with a spring return to allow the alternating of the pump sequence to check alternator operation.

H. Lights and Alarms

1. Indicator Lights - There shall be installed on the face of the inner door unit, heavy duty oil tight indicator lights as shown on the Standard Drawings.

2. High Level Alarm - A vapor proof red light and horn shall be mounted on top of the panel for high level alarm. Also, there shall be an alarm silence pushbutton on the inner door and a silence relay which will silence the horn and automatically reset when these signals are restored to normal. The pushbutton shall be heavy duty oil tight. The red globe shall be the screw-on type.

I. Emergency Power Receptacle

This item shall only be required on stations that do not have a permanent standby generator system. The panel shall have an external mounted generator receptacle of the required size. (See approved manufacturer's list).

J. Additional Requirements

1. Wiring - All power wires shall be THW and THWN 75 Degree C insulated stranded copper conductors and shall be appropriately sized for the given load application. All control circuit wire shall be type THW; Size 14, stranded type. All wiring within he enclosure shall be neatly routed by the use of slotted type wiring duct with snap on type covers. Wiring on the rear of the inner door shall be neatly bundled with nylon ties and include sufficient loop across the hinges to prevent wire damage, with each end of conductor marked (I.D.), Color: Red, 24 volt; white, neutral; black, 120 volts.

2. Terminal Points - Terminal points of all terminal strips shall be permanently identified. All terminal numbers and identifying nomenclature shall correspond to and be shown on electrical diagrams. All wiring shall be permanently shown on electrical schematic diagrams.

3. Engraved Nameplates - All circuit breakers, control switches, indicator pilot lights and other control devices shall be identified with permanently affixed legend plates and lamicoid-type engraved nameplates where applicable.

4. Surge Protector - A surge protector shall be included and wired to protect motors and control equipment from lighting induced line surges. All surge protectors shall be U.L. approved and installed per respective power company requirements and manufacturers' specifications, surge protectors shall be attached to the main disconnects.

5. Elapsed Time Meters - Elapsed time meters shall be 115 volt not-reset type and shall totalize pump running time in hours and tenths of hours to 99999.9 hours.

6. Convenience Receptacle - On the face of the inner door unit, there shall be installed a 15 AMP 120 volt, duplex convenience receptacle. It shall be provided with it's own single pole, 15 AMP circuit breaker for protection. Ground fault interrupt type shall be required.

7. Control Terminal Blocks - Control terminal blocks shall be of the clamp screw type, rated for 600 volts. Amperage rating shall accommodate the control circuit amperage. An additional 30 space terminal strip shall be installed in the cabinet for future use, with RTU equipment.

8. Control Power Transformer - There shall be a control power transformer with a minimum size of 500VA to provide 120VAC power for: coils for starters, 15A duplex receptacle, indicator pilot lights, alarm horn, alarm light, pump alternator, elapsed time meters etc. The secondary side shall have one leg fused and the secondary side shall have one leg fused and the other grounded. This control power transformer is required only on 480 volt control panels.

   The signal required by the float switches and relays shall be 24VAC. This shall be provided by a 24VAC control power transformer properly sized with a fused secondary.

9. Control Relay - The level control relays shall operate from 24VAC. They shall be enclosed, plug-in 8 pin type with octal-style screw terminal sockets.

10. Electrical Schematic - There shall be permanently affixed to the interior side of the exterior enclosure door an electrical schematic diagram and a copy supplied to County personnel at start-up. The schematic diagram shall include the rated amperage and voltage for all components.

11. Phase Monitor - For all 240 volt stations an eight pin plug-in type phase monitor shall be provided for protection of electrical components due to phase loss. Adequate dummy pin protection shall be provided to prevent accidental interchanging of the eight pin phase monitor with the eight pin alternator. All 480 volt stations shall have surface mount type phase monitors.

K. Testing, Service and Warranty

1. Testing - After fabrication in the control panel manufacturer's plant, an operational test shall be performed to check out the entire panel before delivery. Three phase source voltage to which the panel is intended for shall be used for the testing.

2. Service - The control panel manufacturer shall maintain a service organization in Orange County that is available for service.

3. Warranty - The manufacturer shall furnish a five (5) year warranty against defects in materials and workmanship covering parts and labor on all items supplied under this section.

END OF SECTION

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SECTION 31 31 00 – SOIL TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes pre-construction soil treatment for underslab and foundation wall perimeters.

1.3 SUBMITTALS

A. Submit the following according to Division 01 requirements.

B. Product Data:

1. Chemicals and products used
2. Application instructions
3. Certification that products used comply with U.S. Environmental Protection Agency (EPA) regulations for termiticides.
4. Information that soil treatment conforms to specified requirements

C. Provide information regarding the type of equipment to be used to apply the soil treatment, size of volume mixing tank, the pump capacity in gallons per minute, and the application tools with in-line flow meter devices attached.

D. Certificate of Compliance: Submit as part of the Close Out Documents the following statement from the pest control company: “The building has received a complete treatment for the prevention of subterranean termites. Treatment is in accordance with rules and laws established by the Florida Department of Agriculture and Consumer Services.”

E. Submit job site log book.

F. Submit warranty.

1.4 QUALITY ASSURANCE

A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for preparing substrate and application.

B. Engage a professional pest control operator who is licensed according to regulations of the State of Florida.

C. Use only termiticides that bear a federal registration number of the EPA and are approved by local authorities having jurisdiction.

1.5 JOB CONDITIONS

A. Restrictions: Do not apply soil treatment solution until excavating, filling, and grading operations are completed, except as otherwise required in construction operations.

B. To ensure penetration, do not apply soil treatment to excessively wet soils or during inclement weather. Comply with handling and application instructions of the soil toxicant manufacturer.

1.6 REGULATORY REQUIREMENTS

A. Minimum requirements for application as authorized by the State of Florida to fulfill the work according to manufacturer’s specifications.

1.7 PROJECT RECORD DOCUMENTATION

A. Log Book to be kept at job site ad to include:

1. Project name
2. Company providing treatment
3. Applicator’s name
4. Time of arrival and departure
5. Product name
6. Record date of all applications
7. Rate of application to all required areas of the designated site
8. All areas to be treated
9. The soil treatment trade name
10. Quantity of concentrate delivered to the site
11. Quantity used for the designated treated areas
12. The percentage of active ingredient in diluted form
13. Finished gallons of soil treatment for each application
14. Linear and square footage amount to determine total finished soil treatment used

B. Owner’s representative will observe both the amount of concentrate delivered to the site and the empty units that total the amount used to the treated areas. The Owner’s representative shall sign the logbook as noted.

1.8 DELIVERY

A. The State Registered products must be delivered to the jobsite in the original sealed and labeled containers of the manufacturer. Use a synthetic dye for proper identification on the surface areas treated.

1.9 WARRANTY

A. Warranty: Furnish written warranty, executed by Applicator and Contractor, certifying that applied soil termiticide treatment will prevent infestation of subterranean termites. If subterranean termite activity is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

B. Warranty Period: 5 years from Date of Substantial Completion, or the minimum more than 5 years if prevailing local laws require.

C. The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 SOIL TREATMENT SOLUTION

A. Use an emulsible, concentrated termiticide that dilutes with water, specially formulated to prevent termite infestation. Fuel oil will not be permitted as a dilutent. Provide a solution consisting of one of following chemical elements.

B. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Permathrin:

1) “Dragnet SFR” manufactured by FMC Corp.
2) “Prelude “manufactured by Zeneca.

b. Cypermethrine: “Prevail FT” manufactured by FMC Corp.
c. Chloronicotinyl: “Premise 75” manufactured by Bayer Corp.

C. Dilute with water to concentration level recommended by manufacturer.

PART 3 - EXECUTION

3.1 APPLICATION

A. Surface Preparation: Remove foreign matter 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 foundations. Toxicants may be applied before placing compacted fill under slabs if recommended by toxicant manufacturer.

B. Application Rates: Apply the soil treatment listed above as a water emulsion at not less than the percentage (in finished solution) designated according to manufacturer’s label specification.

C. Post signs in areas of application to warn workers that soil termiticide treatment has been applied. Remove signs after areas are covered by other construction.

D. Reapply soil treatment solution to areas disturbed by subsequent excavation, rain, landscape grading, or other construction activities following application.

E. Provide all items and accessories as required for a complete and total application in every respect.

F. Spaces in floor slab that are boxed out or cut away shall use a metal form of sufficient depth to eliminate any planned soil disturbances after initial chemical treatment.

END OF SECTION 31 31 00

SECTION 31 31 18 - PEST CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Provide treatment for pest control.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical data and application instructions in accordance with Division 01 requirements.

B. Submit specific product warranty as specified herein.

1.4 QUALITY ASSURANCE

A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work, including preparation of substrate application.

B. Engage a professional pest control operator, licensed in accordance with regulations of governing authorities for application of soil treatment solution.

C. Use only chemicals that bear a Federal registration number of the U.S. Environmental Protection Agency.

1.5 SPECIFIC PRODUCT WARRANTY

A. Furnish written warranty, certifying that applied insecticide treatment will prevent infestation of common household insects such as cockroaches, ants, and fleas for a one year period. Re-treat if insect activity is discovered during warranty period.

PART 2 - PRODUCTS

2.1 PEST CONTROL SOLUTION

A. Use an emulsible concentrated insecticide for dilution with water, specially formulated to prevent infestation by insects. Fuel oil will not be permitted as a diluent.

1. Exterior use; “Termidor SC” by BASF – EPA Registered
2. Interior use; “Demand CS” by Syngenta – EPA Registered

B. Other solutions may be used as recommended by Applicator if also acceptable to Architect and approved for intended application by jurisdictional authorities. Use only insecticide treatment solutions that are not injurious to planting.

PART 3 - EXECUTION

3.1 APPLICATION

A. Surface Preparation: Remove foreign matter that could decrease treatment effectiveness on areas to be treated.

B. Application Rates: Mix chemicals (from sealed containers) with water, at the job-site, and then apply concentrate solution only at rates described by the manufacturer on the product label and in compliance with State of Florida laws.

C. Apply to all interior floor-to-wall corners and around building perimeter at existing grades.

D. Apply pest control to all interior spaces of buildings included but not limited to each side of bottom of interior walls, interior side of exterior walls, bottom of vinyl bases, perimeter of windows, bottom of exterior side of exterior wall and any other areas/openings on exterior side of building(s).

1. The Owners Grounds and Pest Control department shall be contacted at least one (1) week prior to the first application in order to verify planned treatments and to confirm the appropriateness of the products to be used.

E. Post signs in areas of application to warn workers that insecticide treatment has been applied. Remove signs when areas are covered by other construction.

F. Re-apply concentrate solution to areas disturbed by construction activities following application.

G. Applicator shall mix all treatment on-site and the Owner’s representative shall witness mixing.

H. Three treatments will be required.

1. Immediately after building is considered dried-in by the Architect.
2. One week prior to the expected Date of Substantial Completion.
3. After the eleventh month, prior to the expiration of the one-year warranty period. This treatment will be considered an item on the Warranty Corrections and Completions List.

I. Applicator shall treat all interior spaces of buildings including but not limited to each side of bottom of interior walls, interior side of exterior walls, bottom of vinyl bases, Perimeter of windows, bottom of exterior side of exterior wall, and any other areas/ openings on exterior side of building.

END OF SECTION 31 31 18

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Division 32

Exterior Improvements

SECTION 32 18 01 – ARTIFICIAL GRASS FIELD TURF

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Furnish all labor, materials, tools and equipment necessary to install monofilament artificial grass field turf as indicated on the plans and as specified herein; including components and accessories required for a complete installation including but not limited to:

1. Acceptance of prepared sub-base.
2. Coordination with related trades to ensure a complete, integrated, and timely installation: Aggregate base course, sub-base material (tested for permeability), grading and compacting, piping and drain components (when required); as provided under its respective trade section.

B. The contractor for the Work of this Section shall be responsible for the excavated grade up. Inclusive of all items including the sub-base.

C. Contractor for the Work of this Section shall also provide and install the irrigation system and the under drain system previously specified or indicated on the Drawings.

D. Geotech fabric is also included under the Work of this Section.

1.3 SUBMITTALS

A. Provide substantiation that proposed system does not violate any other manufacturer's patents, patents allowed or patents pending.

B. Provide a sample copy of insured, non-prorated warranty and insurance policy information.

C. Shop Drawings:

1. Indicate field layout; field marking plan and details for the specified sports; i.e., NFHA Football; soccer, girl’s lacrosse and boys lacrosse, roll/seaming layout; methods of attachment, field openings and perimeter conditions, base section, irrigation piping and drainage.
2. Show installation methods and construction indicating field verified conditions, clearances, measurements, terminations, drainage.
3. Provide joint submission with related trades when requested by Architect.

D. Product Data:

1. Submit manufacturer's catalog cuts, material safety data sheets (MSDS), brochures, specifications; preparation and installation instructions and recommendations; storage, handling requirements and recommendations.
2. Submit fiber manufacturer's name, type of fiber and composition of fiber.
3. Submit data in sufficient detail to indicate compliance with the contract documents.
4. Submit manufacturer's instructions for installation.
5. Submit manufacturer's instructions for maintenance for the proper care and preventative maintenance of the synthetic turf system, including painting and markings.

E. Samples: Submit samples, 9 x 12 inches, illustrating details of finished product in amounts as required by General Requirements, or as requested by Architect.

F. Product Certification:

1. Submit manufacturer’s certification that products and materials comply with requirements of the specifications.
2. Submit test results indicating compliance with Reference Standards.

G. Project Record Documents: Record actual locations of seams, drains and other pertinent information in accordance with Specifications, General Requirements.

H. List of existing installations: Submit list including respective Owner’s representative and telephone number.

I. Warranties: Submit warranty and ensure that forms have been completed in Owner's name and registered with approved manufacturer.

J. Testing Certification: Submit certified copies of independent (third-party) laboratory reports on ASTM testing:

1. Pile Height, Face Weight & Total Fabric Weight, ASTM D5848.
2. Primary & Secondary Backing Weights, ASTM D5848.
3. Tuft Bind, ASTM D1335.
4. Grab Tear Strength, ASTM D1682 or D5034.
5. Water Permeability, ASTM D4491

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section. The turf contractor and/or the turf manufacturer:

1. Shall be experienced in the manufacture and installation of specified type of infilled spined and/or ridged monofilament grass system for a minimum of three years. This includes use of a spined and/or ridged monofilament fiber, backing, the backing coating, and the installation method.
2. The manufacturer shall own and operate its own manufacturing plant. Manufacturing the fiber, tufting of the field fibers into the backing materials and coating of the turf system must be done in-house by the turf manufacturer.
3. The manufacturer must have ISO 9001, ISO 14001 and OHSAS 18001 certifications demonstrating its manufacturing efficiency with regards to quality, environment and safety management systems.
4. The manufacturer must be a FIFA Preferred Producer and a FIFA Licensee
5. The manufacturer must be licensed by all of the following major international governing bodies: FIFA, International Rugby Board (IRB), International Hockey Federation (FIH), Australian Football League (AFL).
6. Shall have 500 fields in play for at least two years with a spined and/or ridged monofilament fiber. Fields shall be 65,000 ft^2 or more
7. Shall have a minimum of 500 fields that are at least 8 years old, which is equal to the respective warranty period, with the same infill system.
8. Shall have a minimum of 25 installations in the State of Florida.
9. Shall have a minimum of 3 FIFA 2-Star recommended field in North America.
10. Shall have a minimum of 10 NFL game and/or practice fields in play for the previous year.
11. Shall have minimum 50 NCAA Division 1 game and/or practice fields installed for (football or soccer)
12. Shall have a minimum of 1000 installations in North America, each of 65,000 ft^2 or more. Fields shall be 65,000 ft^2 or more of the specified infill material and a spined and/or ridged monofilament fiber.
13. Shall provide third party certification confirming minimum requirement of 9 lbs tuft bind.
14. Specified turf system shall have attained 800 impactions with an Ultimate Gmax of no more than 140G’s as per Testing Services Inc test number TSI 1202. Specified turf system must have the same infill composition as the product tested.

B. Installer: Company shall specialize in performing the work of this section. The Contractor shall provide competent workmen skilled in this specific type of synthetic grass installation.

C. The designated Supervisory Personnel on the project shall be certified, in writing by the turf manufacturer, as competent in the installation of specified monofilament material, including sewing seams and proper installation of the infill mixture.

D. Installer shall be certified by the manufacturer and licensed.

E. The installer supervisor shall have a minimum of 5 years experience as either a construction manager or a supervisor of synthetic turf installations

F. Pre-Installation Conference: Conduct conference at project site at time to be determined by Architect. Review methods and procedures related to installation including, but not limited to, the following:

G. Inspect and discuss existing conditions and preparatory work performed under other contracts.

H. In addition to the Contractor and the installer, arrange for the attendance of installers affected by the Work, The Owner’s representative, and the Architect.

I. The Contractor shall verify special conditions required for the installation of the system.

J. The Contractor shall notify the Architect of any discrepancies.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prevent contact with materials that may cause dysfunction.

B. Deliver and store components with labels intact and legible.

C. Store materials/components in a safe place, under cover, and elevated above grade.

D. Protect from damage during delivery, storage, handling and installation. Protect from damage by other trades.

E. Inspect all delivered materials and products to ensure they are undamaged and in good condition.

F. Comply with manufacturer’s recommendations.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate the Work with installation of work of related trades as the Work proceeds.

B. Sequence the Work in order to prevent deterioration of installed system.

1.7 WARRANTY AND GUARANTEE

A. The Contractor shall provide a warranty to the Owner that covers defects in materials and workmanship of the turf for a period of eight (8) years from the date of substantial completion. The turf manufacturer must verify that their representative has inspected the installation and that the work conforms to the manufacturer's requirements. The manufacturer's warranty shall include general wear and damage caused from UV degradation. The warranty shall specifically exclude vandalism, and acts of God beyond the control of the Owner or the manufacturer. The warranty shall be fully third party insured; pre paid for the entire 8 year term and be non-prorated. The Contractor shall provide a warranty to the Owner that covers defects in the installation workmanship, and further warrant that the installation was done in accordance with both the manufacturer's recommendations and any written directives of the manufacturer's representative. Prior to final payment for the synthetic turf, the Contractor shall submit to owner notification in writing that the field is officially added to the annual policy coverage, guaranteeing the warranty to the Owner. The insurance policy must be underwritten by an “AM Best” A rated carrier and must reflect the following values:

1. Pre-Paid 8-year insured warranty.
2. Insured Warranty Coverage must be provided in the form of 1 single policy
3. Maximum per claim coverage amount of $32,000,000.
4. Minimum of thirty-two million dollar ($32,000,000) annual aggregate
5. Must cover full 100% replacement value of total square footage installed, minimum of $7.00 per sq ft. (in case of complete product failure, which will include removal and disposal of the existing surface)
6. Policies that include self insurance or self retention clauses shall not be considered.
7. Policy cannot include any form of deductible amount.
8. Sample policy must be provided at time of bid to prove that policy is in force. A letter from an agent or a sample Certificate of Insurance will not be acceptable.

B. The artificial grass system must maintain a G-max of less than 200 for the life of the Warranty as per ASTM F1936.

1.8 MAINTENANCE SERVICE

A. Contractor shall train the Owner's facility maintenance staff in the use of the turf manufacturer's recommended maintenance equipment.

B. Manufacturer must provide maintenance guidelines and a maintenance video to the facility maintenance staff.

PART 2 - MATERIALS

2.1 ACCEPTABLE MANUFACTURER

A. Basis of design Product and Manufacturer; FieldTurf USA Inc., FieldTurf Revolution 360 using CoolPlay cooling technology, or approved equal.

B. Provide and install the geotech fabric.

2.2 MATERIALS AND PRODUCTS

A. Artificial grass FieldTurf system materials shall consist of the following:

1. Carpet made of “spined and/or ridged” monofilament polyethylene fibers tufted into a fibrous, non-perforated, porous backing.
2. Infill: Controlled mixture of graded sand and cryogenic rubber crumb that partially covers the carpet, with a topping layer of CoolPlay extruded composite.
3. Glue, thread, paint, seaming fabric and other materials used to install and mark the artificial grass monofilament FieldTurf.

B. The installed artificial grass monofilament FieldTurf shall have the following properties:

1.	ASTM D1577	Fiber Denier	-	14,500
2.	ASTM D1577	Fiber Thickness	-	380 Microns
			-	HALS UV Stabilizer 10,000ppm
3.	ASTM D5823	Pile Height	-	2 1/2”
4.	ASTM D5793	Stitch Gauge	-	3/4”
5.	ASTM D5848	Pile Weight	-	42oz/square yard
6.	ASTM D5848	Primary Backing	-	7+oz/square yard
7.	ASTM D5848	Secondary Backing	-	14+oz/square yard
8.	ASTM D5848	Total Weight	-	63+oz/square yard
9.	ASTM D1335	Tuft Bind (Without Infill)	-	8+ lbs
10.	ASTM D5034	Grab Tear (Width)	-	200 lbs/force
11.	ASTM D5034	Grab Tear (Length)	-	200 lbs/force
12.	ASTM D4491	Carpet Permeability	-	>40 inches/hour
13.	ASTM F1936	Impact Attenuation (Gmax)	-	<200
		Infill Material Depth	-	1.75 inches
		Sand Infill Component		6.2lbs/square foot
		SBR Rubber Infill Component		2.6lbs/square foot
		Extruded Composite Component		0.4lbs/square foot
		Total Product Weight		1388oz/square yard

C. Carpet shall consist of spined and/or ridged monofilament fibers tufted into a primary backing with a secondary backing.

D. Carpet Rolls shall be 15’ wide rolls.

1. Rolls shall be long enough to go from field sideline to sideline.
2. Where the playing field is for football, the perimeter white line shall be tufted into the individual sideline rolls.

E. Backing:

1. Primary backing shall be a double-layered polypropylene fabric
2. Secondary backing shall consist of an application of porous, heat-activated urethane to permanently lock the fiber tufts in place.
3. Perforated (with punched holes), backed carpet are unacceptable.

F. Fiber shall be 14,500 denier, low friction, and UV-resistant fiber measuring not less than 2 ½ inches high.

1. Systems with less than a 2 ½ inch fibers are unacceptable.

G. Infill materials shall be approved by the manufacturer.
1. Infill shall consist of a resilient layered granular system, comprising selected and graded sand and cryogenically hammer-milled SBR rubber crumb, with a top layer of CoolPlay extruded composite. Artificial Grass products without cryogenically processed SBR rubber and a top layer of extruded composite infill will not be acceptable.
2. The sand component of the infill must represent a minimum of 51% or more of the total infill, by weight.

H. The sand infill will comply within the following characteristics:

1. Average Particle size between 20 and 30 mesh [calculated based on summing the midpoint of sieve pan fractions times the % retained on given screen fractions]
2. Average Particle shape > 0.4 on the Krumbein scale
3. Particle structure predominantly single grain
4. Produce < 0.4%, -50M in API crush test at 80psig

I. Non-tufted or inlaid lines and markings shall be painted with paint approved by the synthetic turf manufacturer.

J. Thread for sewing seams of turf shall be as recommended by the synthetic turf manufacturer.

K. Glue and seaming fabric for inlaying lines and markings shall be as recommended by the synthetic turf manufacturer.

2.3 QUALITY CONTROL IN MANUFACTURING

A. The manufacturer shall operate its own manufacturing plant. Manufacturing the fiber, tufting of the field fibers into the backing materials and coating of the turf system must be done in-house by the turf manufacturer. Outsourcing of any of these major processes is unacceptable.

B. The manufacturer shall have full-time certified in-house inspectors at their manufacturing plant that are experts with industry standards.

C. Primary backing shall be inspected by the manufacturer’s full-time certified in-house inspectors before tufting begins.

D. The manufacturer’s full-time in-house certified inspectors shall verify “pick count”, yarn density in relation to the backing, to ensure the accurate amount of face yarn per square inch.

E. The manufacturer’s full-time, in-house, certified inspectors shall perform turf inspections at all levels of production including during the tufting process and at the final stages before the turf is loaded onto the truck for delivery.

F. The manufacturer shall have its own, in-house laboratory where samples of turf are retained and analyzed, based on standard industry tests, performed by full-time, in-house, certified inspectors.

G. The manufacturer must have ISO 9001, ISO 14001 and OHSAS 18001 certifications demonstrating its manufacturing efficiency with regards to quality, environment and safety management systems.

2.4 QUALITY CONTROL IN FIBER MANUFACTURING

A. Synthetic turf fiber must perform in a uniform manner or manufacturer quality control issues in the extrusion processes will be suspected. Linear Low Density Polyethylene Polymer ("LLDPE") and batch additives obtained from a reputable manufacturer are required to manufacture superior quality monofilament yarn. The master batch formula must include a UV stabilizer package added to its polymer base.

B. The LLDPE used to make the artificial grass fiber needs to be a "C6" LLDPE which contains 6 carbon atoms and 13 hydrogen atoms; A C6-based LLDPE produces strong and resilient artificial grass fibers over prolonged periods and thus should provide the basis for long term performance of the system.

C. Adequate UV protection is essential to the long-term durability of any artificial grass fiber. Typically, stabilizer packages for polyethylene fibers have three components that protect the fibers from degradation: (1) primary antioxidants; (2) secondary antioxidants; and (3) UV stabilizers (i.e., hindered amine light stabilizers ("HALS")). HALS are a particularly important aspect of the stabilizer package. A typical HALS concentration is 10,000 ppm. More developed HALS molecules are methyl stabilized to prevent from degradation.

D. Streaking refers to color variation in a field due to different degrees of fiber relaxation. Fiber in one row stands up, while fiber in an adjacent row lies flat. The inconsistent relaxation causes differences in the reflection of light off of the fiber, and results in the field having a streaked or striped appearance. Adequate UV protection minimizes the appearance of streaking and other visual flaws during the warranty period.

2.5 FIELD GROOMER & SWEEPER

A. Supply field groomer as part of the work.

1. Field Groomer shall include a towing attachment compatible with a field utility vehicle.
2. Field Groomer shall be a FieldTurf GroomRight
3. Field Sweeper shall include a towing attachment compatible with a field utility vehicle.
4. Field Sweeper shall be a FieldTurf SweepRight

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that all sub-base leveling is complete prior to installation.

B. Installer shall examine the surface to receive the synthetic turf and accept the sub-base planarity in writing prior to the beginning of installation.

C. Acceptance is dependent upon the Owner’s test results indicating compaction and planarity are in compliance with manufacturer’s specifications.

D. The surface shall be accepted by Installer as “clean” as installation commences and shall be maintained in that condition throughout the process.

E. Compaction of the aggregate base shall be 95%, in accordance with ASTM D1557 (Modified Proctor procedure); and the surface tolerance shall not exceed 0-1/4 inch over 10 feet and 0-½" from design grade.

F. Correct conditions detrimental to timely and proper completion of Work.

G. Do not proceed until unsatisfactory conditions are corrected.

H. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

A. Prior to the beginning of installation, inspect the sub-base for tolerance to grade.

B. Sub-base acceptance shall be subject to receipt of test results (by others) for compaction and planarity that sub-base is in compliance with manufacturer’s specifications and recommendations.

C. Dimensions of the field and locations for markings shall be measured by a registered surveyor to verify conformity to the specifications and applicable standards. A record of the finished field as-built measurements shall be made.

D. When requested by Architect, installed sub-base shall be tested for porosity prior to the installation of the monofilament turf. A sub base that drains poorly is an unacceptable substrate.

3.3 INSTALLATION - GENERAL

A. The installation shall be performed in full compliance with approved Shop Drawings.

B. Only trained technicians, skilled in the installation of athletic caliber synthetic turf systems working under the direct supervision of the approved installer supervisors, shall undertake any cutting, sewing, gluing, shearing, topdressing or brushing operations.

C. The designated Supervisory personnel on the project must be certified, in writing by the turf manufacturer, as competent in the installation of this material, including sewing seams and proper installation of the Infill mixture.

D. Designs, markings, layouts, and materials shall conform to all currently applicable National Collegiate Athletic Association rules, NFHS rules, and/or other rules or standards that may apply to this type of synthetic grass installation. Designs, markings and layouts shall first be approved by the Architect or Owner in the form of final shop drawings. All markings will be in full compliance with final shop drawings.

3.4 INSTALLATION

A. Install at location(s) indicated, to comply with final shop drawings, manufacturers’/installer’s instructions.

B. The Contractor shall strictly adhere to specified procedures. Any variance from these requirements shall be provided in writing, by the manufacturer’s on-site representative, and submitted to the Architect and/or Owner, verifying that the changes do not in any way affect the Warranty. Infill materials shall be approved by the manufacturer and installed in accordance with the manufacturer’s standard procedures.

C. Carpet rolls shall be installed directly over the properly prepared aggregate base. Extreme care shall be taken to avoid disturbing the aggregate base, both in regard to compaction and planarity.

1. Repair and properly compact any disturbed areas of the aggregate base as recommended by manufacturer

D. Full width rolls shall be laid out across the field.

1. Turf shall be of sufficient length to permit full cross-field installation from sideline to sideline.
2. No cross seams will be allowed in the main playing area between the sidelines.
3. Each roll shall be attached to the next roll utilizing standard state-of-the- art sewing procedures.
4. When all of the rolls of the playing surface have been installed, the sideline areas shall be installed at right angles to the playing surface.

E. Artificial turf panel seams shall be sewn along the selvedge edging flap of the turf roll. Seams secured by other means including gluing are unacceptable. Installation shall be 99% sewn.

1. Minimum gluing will only be permitted to repair problem areas, corner completions, and to cut in any logos or inlaid lines as required by the specifications.
2. Seams shall be flat, tight, and permanent with no separation or fraying.
3. In the case of all lines and logos, turf carpet/field fibers must be sheared to the backing (do not cut the backing) and adhered using hot melt adhesives.

F. Infill Materials:

1. Infill materials shall be applied in numerous thin lifts. The turf shall be brushed as the mixture is applied. The infill material shall be installed to a depth determined by the manufacturer.
2. Three-layered infill shall be installed in a systematic order.
3. Infill materials shall be installed to fill the voids between the fibers and allow the fibers to remain vertical and non-directional. The Infill installation consists of a base layer of sand followed by a homogenous mixture of the sand and the cryogenically processed rubber. A final application of specifically sized extruded composite infill completes the system. The Infill shall be installed to the depth of 1 ¾”. Infill density shall consist of no more than

6.2 pounds of sand and at least 2.6 pounds of rubber per square foot. The Infill shall be placed so that there is a void of ¾” to the top of the fibers.

G. Non-tufted or inlaid lines and markings shall be painted in accordance with turf and paint manufacturers’ recommendations. Number of applications will be dependent upon installation and field conditions.

H. Synthetic turf shall be attached to the perimeter edge detail in accordance with the manufacturer’s standard procedures.

I. Upon completion of installation, the finished field shall be inspected by the installation crew and an installation supervisor.

J. Provide all items and accessories as required for a complete installation in every respect.

3.5 FIELD MARKINGS

A. Field markings shall be installed in accordance with approved shop drawings. If football is designated as the primary sport, all five yard lines will be tufted-in.

B. Balance of sports markings will be inlaid or painted in accordance with the Drawings.

C. Center field logo shall be either painted or inlaid according to artwork indicated on Drawings and in accordance with manufacturer’s standard palette of turf colors.

D. End-zone letters and logos shall be either painted or inlaid according to artwork and fonts indicated on the Drawings, and in accordance with manufacturer’s standard palette of turf colors.

3.6 ADJUSTMENT AND CLEANING

A. Do not permit traffic over unprotected surface.

B. Contractor shall provide the labor, supplies, and equipment as necessary for final cleaning of surfaces and installed items.

C. All usable remnants of new material shall become the property of the Owner.

D. The Contractor shall keep the area clean throughout the project and clear of debris.

E. Surfaces, recesses, enclosures, and related spaces shall be cleaned as necessary to leave the work area in a clean, immaculate condition ready for immediate occupancy and use by the Owner.

3.7 PROTECTION

A. Protect installation throughout construction process until date of final completion.

END OF SECTION 32 18 10

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SECTION 32 18 22 – TRACK SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:

1. Track Surfacing.

1.3 REFERENCES

A. The National Federation State High Schools Association Court and Field Diagram Guide.

B. United States Tennis Court (USTC) & Track Builders Association (TBA).

C. FDOT current edition Standard Specifications.

1.4 SUBMITTALS

A. Product Data: Manufacturer's specifications and installation instructions. Include data substantiating that materials comply with specified requirements. Indicate that installer has received copy of manufacturer's instructions.

B. Layouts for Running Track and Field Events

1. Submit Shop Drawings to show the tracks and fields event layouts, including metric lane markings, passing zones, start and finish lines, and other markings required in accordance with The National Federation of State High School Association's High School Track and Field Rules and Records. These Drawings shall be reviewed by the Architect; then will be sent to the Owner for his comments and approval.
2. The layout of the track and field events shall conform with the above Shop Drawings. Upon completions of striping and layout Work, the Contractor shall submit to the Architect an "As Built Drawing" prepared by a licensed surveyor or certifying that all points and layouts shown on the approved shop drawing are located where required.
3. Drawings shall show the surveyor's name, address, and surveyor's license number. The cost of this Work shall be included in the Contractor's bid.

C. Samples: 3-inch by 3-inch of exact surface to be installed.

D. Maintenance Submittal: Provide Owner with written instructions for the track use and maintenance requirements in accordance with the Warranty.

1.5 QUALITY ASSURANCE

A. Contractor Qualifications: Installation of synthetic surfacing shall be performed by a Contractor who has a minimum of 5 years experience in the field and can demonstrate successful completion of similar projects.

B. Contractor shall be knowledgeable with regard to rules of track and field as they relate to facilities, variations between the governing bodies, orientation, site layout, drainage, soil issues, and surface requirements.

1. Calculations for track dimensions shall be made by a certified track-computing statistician.
2. Running Track calculations shall be in meters.

C. Contractor Certifications:

1. Contractor shall provide written verification that running tracks are certified and calibrated correctly.

D. A representative of the Manufacturer of the synthetic material shall be at the jobsite during performance of the Work to assist and advise the asphalt plant in establishing the proper mix and to assist and advise the Contractor on all phases of the synthetic surfacing installation.

E. Track shall be certified by a third party agency.

F. Codes and standards follow the current guidelines set forth by the International Amateur Athletic Federation (IAAF) and the National Collegiate Athletic Association (NCAA), along with the current material testing guidelines as published by the American Society of Testing and Materials (ASTM) and comply with NFHSA (National Federation of HighSchool Associations).

G. The Contractor and the Manufacturer must be the same entity.

1. Furnish evidence that they have been in business for a period of not less than 3 years, under the present name.
2. Shall have installed a minimum of 10 outdoor track facilities using the exact, IAAF certified polyurethane synthetic track surfacing, as specified herein with the contractor bidding this project, which are certified to meet IAAF/NCAA rules & regulations, utilizing the same product as specified. Reference list provided is to include contact names and phone numbers.

1.6 PROJECT CONDITIONS

A. Do not begin track and field events Work before completion of final grading and surfacing.

B. No part of construction involving track products shall be conducted during a rainfall or when rainfall is imminent or unless both ambient and materials temperature are at least 50 degrees F. (10 degrees C.) and rising.

C. After a rainfall, sufficient time shall be given to allow the surface to dry before resuming Work. Surface shall be dry, as well as clean, since moisture on the surface on hot days can turn to steam or vapor. If moisture is trapped under an application of material, blisters may occur.

D. The facilities shall not be used for a minimum period of 1 week after completion of construction.

1.7 WARRANTY

A. Contractor’s Warranty: Provide written warranty that base course and finish surfacing materials for running track and play courts shall not crack, deteriorate, blister or delaminate for indicated warranty period.

1. Warranty Period: Not less than five years from date of substantial Completion.
2. Synthetic surfacing material found to be defective as a result of faulty workmanship and/or material failure shall be replaced or repaired at no charge, upon written notification within the guarantee period.

PART 2 - PRODUCT SYSTEM

2.1 PERFORMANCE STANDARDS

A. The Track Surfacing System shall exhibit the following minimum performance standards as required by IAAF:

1. Thickness > 13mm
2. Force Reduction 35 to 50%
3. Modified Vertical Deformation 0.6 to 1.8mm
4. Friction > 47 TRRL Skid Resistance
5. Tensile Strength > 0.5MPa
6. Elongation at Break > 40%

2.2 CONFIGURATION FOR RUNNING TRACK

1. Standard 400 meter, Double Bend Track with eight (8) lanes, with all event markings in accordance with USTC & TBA standards.
2. Line painting and events markings shall be in accordance with the National Federation of State High School Association track and field rules book, latest edition.

2.3 GENERAL

A. Conform to manufacturer's current specification. The surfacing system shall be complete and consist of components, blended and mixed in the prescribed manner, placed and installed with the recommended equipment to provide the best finished product available from the manufacturer.

2.4 MANUFACTURERS

A. Basis of Design Product and Manufacturer; BSS 200, Beynon Sports Surfaces.

B. Other acceptable manufacturers are but not limited to as follows:

1. Advanced Polymer Technologies or Approved Equal.

C. Thickness: 13mm.

2.5 MATERIALS

A. Primers; polyurethane-based primer specifically formulated to be compatible with paved-in-place SBR granules and track surfacing material.

B. SBR Granules; recycled SBR rubber, processed and chopped to 1-3mm size, containing less than 1% dust.

1. Color: Black.

C. EPDM Granules; EPDM peroxide cured, synthetic rubber containing a minimum 20% EPDM resin, with a specific gravity of 1.5 ± 0.1 g/cm3. The EPDM rubber shall be the same color as chosen by the owner for the track surface.

D. Polyurethane Binder; MDI-based single-component, polyurethane binding agent. Solvent free, TDI monomer shall be less than 0.2%. The binder must be specially formulated for compatibility with SBR rubber crumb.

E. Structural Spray Coating; MDI-based single-component, moisture cured, 100% solids, pigmented polyurethane, specifically formulated for compatibility with EPDM granules.

1. Color: As Selected by Architetc from Manufacturers full range.

F. Line Marking Paint; single component, moisture cured, aliphatic polyurethane paint compatible with the Track Surfacing material.

PART 3 - EXECUTION

3.1 PREPERATION

A. Track Surfacing System shall be laid on an approved subbase.

B. The General Contractor shall provide compaction test results of 95% or greater for the installed subbase and asphalt surface.

C. For NFHSA certification the following criteria must be followed. The track surface, i.e. asphalt substrate, shall not vary from planned cross slope by more than + .2%, with a maximum lateral slope outside to inside of 1%, and a maximum slope of 0.1% in any running direction. The finished asphalt shall not vary under a 10' straight edge more than 1/8”.

D. Any oil spills (hydraulic, diesel, motor oil, etc.) must be completely removed, either by chipping out or removing and replacing with new, keyed in asphalt. The minimum depth of any asphalt replacement shall be one inch. The curing time for the asphalt base is 28 days. It shall be the responsibility of the surfacing contractor to determine if the asphalt substrate has cured sufficiently prior to the application of polyurethane surfacing system.

E. It shall be the responsibility of the general contractor to determine if the asphalt substrate meets all design specifications, i.e. cross slopes, planarity and specific project criteria. After all the above conditions are met, the synthetic surfacing contractor must, in writing, accept the planarity of the asphalt receiving base before work can commence.

F. The Synthetic Track Surfacing System components shall be processed and installed by specially designed machinery and equipment. A mechanically operated paver with variable

regulated speed and thermostatically controlled screed shall be used in the installation of the base mat. The wearing course shall be installed using automatic electronic portioning, which provides continuous mixing and feeding for an accurate, quality controlled installation.

G. Installation

1. Base Course; SBR granules and binder shall be mixed in accordance with the Manufactures requirements.

2. Wearing Course; EPDM granules and binder shall be mixed in accordance with the Manufactures requirements.

3. Single-component structural spray coating. The structural spray shall be made in two (2) uniform applications.

H. Layout; Line striping and event markings shall be laid out in accordance with current IAAF and NCAA rules.

3.2 TESTING

A. The Owner reserves the right to submit representative samples of the synthetic track surface to an independent testing lab at any time during the length of the Warranty to determine the chemical composition and performance characteristics. Tests will be made to confirm compliance with the Contract Documents and the manufacturer’s specification of the track system.

B. The Owner will be responsible for paying for all initial testing of the synthetic surfacing. If surface is found to be acceptable, the Owner will bear the cost of replacing the core sample areas. Any section found not to be in compliance shall be removed and replaced at the expense of the Contractor. Further testing of the surface that has been replaced will be done by an independent testing lab at the direction of the Owner and at the expense of the Contractor.

C. Samples shall be taken every 1000 square yards. Sample size: approximately 6-inches square. Actual samples removed for testing shall not be reinstalled. Follow manufacturer’s specifications for replacing surfacing within the test core areas.

3.3 ACCEPTABILITY OF WORK

A. Grade conformance tests shall be conducted on the entire surface, and the entire surface should have positive drainage.

B. After completion of finish rolling operations of each course, the compacted surface shall be tested with a 10’ straightedge. Measurements should be made perpendicular to and across all mats at a distance not to exceed 25 feet. The track surface must be free of dips, seam and/or joint depressions, and cracks. The track surfacing contractor shall be present when these measurements are made. The maximum allowable planarity deviation within a pass should be 1/8” in 10’ when measured in any direction.

C. The running track and play court when completed, and before striping, shall be completely free from blemishes, patching scars, and have a uniform finish and color.

3.4 CERTIFICATION

A. Certification and registration of the running track shall be done by a Certified Track Builder (CTB). Certification shall include construction for proper drainage, stable base, quality of synthetic surface (when used) and for accurate marking to include 400 meters.

END OF SECTION 32 18 22

SECTION 32 31 19 – DECORATIVE METAL GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Swing gates.

1.3 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For gates. Include plans, elevations, sections, details, and attachments to other work.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications: Minimum of 5 years’ experience manufacturing aluminum ornamental picket fencing.

1.5 SPECIAL WARRANTY

A. All structural components shall be warranted within specified limitations, by the manufacturer for a period of 20 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding.

B. Reimbursement for labor necessary to restore or replace components that have been found to be defective under the terms of manufactures warranty shall be guaranteed for five (5) years from date of original purchase.

PART 2 - PRODUCTS

2.1 ALUMINUM GATES

A. Decorative Aluminum Gates: Gates made from aluminum extrusions.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ametco, Blade design (horizontal), or a comparable product by one of the following:

a. Or Approved Equal.

B. Gate Configuration: Swing and sliding Gate, as indicated.

C. Gate Frame Height: As indicated.

D. Gate Opening Width: As Indicated.

E. Aluminum Frames and Bracing: Fabricate members from square extruded-aluminum tubes.

F. Gate Posts: Sizes as indicated; manufacturer’s standard metal thickness for applications indicated.

G. Frame Corner Construction: Welded.

H. Infill: Horizontal Blade design.

1. Picket Size: 1/2-inch x 6-inch.
2. Configuration and Spacing: As Indicated.

I. Hardware: Code approved safety latches permitting operation from both sides of gate and hinges.

J. Aluminum Finish: Baked enamel or powder coating.

1. Color: As selected by Architect from Manufacturers full range.

2.2 HARDWARE

A. Swing Gates

1. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.

a. Function: 39 - Full surface, triple weight, antifriction bearing.
b. Material: Manufacturer’s standard for applications indicated.

B. Sliding Gates

1. General: ASTM F 1184 for gate posts and double sliding gate types.
2. Classification: Type II Cantilever Slide, Class 1 with external roller assemblies.
3. Hangers, Roller Assemblies, and Stops: Fabricated from mill-finished Grade 319 aluminum-alloy casting with stainless-steel fasteners.
4. Latch: Permitting operation from both sides of gate.
5. Lock: Manufacturer's standard internal device.

2.3 FABRICATION

A. Pickets, rails and posts shall be pre-cut to specified lengths. Rails shall be pre-punched to accept pickets.

2.4 ALUMINUM

A. Aluminum, General: Provide alloys and tempers with not less than the strength and durability properties of alloy and temper designated in paragraphs below for each aluminum form required.

B. Extrusions: ASTM B 221, Alloy 6063-T5.

C. Tubing: ASTM B 429, Alloy 6063-T6.

D. Plate and Sheet: ASTM B 209, Alloy 6061-T6.

E. Die and Hand Forgings: ASTM B 247, Alloy 6061-T6.

F. Castings: ASTM B 26, Alloy A356.0-T6.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for strength and compatibility in fabricated items.

2.6 ALUMINUM FINISHES

A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 2 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GATE INSTALLATION

A. Set gate posts plumb and level for gate openings specified in construction drawings.

B. Install gates to allow full opening without interference after concrete has hardened around gate posts. Adjust hardware for smooth operation. Install one drop rod for double gates.

C. Gate posts shall be spaced according to the manufacturers’ gate drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected. Type and quantity of gate hinges shall be based on the application; weight, height, and number of gate cycles. The manufacturers’ gate drawings shall identify the necessary gate hardware required for the application. Gate hardware shall be provided by the manufactureof the gate and shall be installed per manufacturer’srecommendations.

3.3 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

END OF SECTION 32 31 19

SECTION 32 84 00 – PLANTING IRRIGATION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. This Section includes piping, valves, sprinklers, specialties, controls, and wiring for an automatic-control irrigation system.

1.3 PERFORMANCE REQUIREMENTS

A. Installer’s qualifications: Have satisfactorily installed irrigation systems on at least five (5) other projects of comparable complexity.

B. Location of Sprinklers and Specialties: Design layout is diagrammatic. Make minor adjustments necessary to avoid plantings and fixed obstructions. Maintain 100 percent water coverage of landscape areas indicated.

1.4 SUBMITTALS

A. Submit manufacturer’s product data and installation instructions for each of the system components for the following. Product Data: Include pressure ratings, rated capacities, and settings of selected models for the following:

1. Electric Valves.
2. Gate Valves
3. Rain Sensor
4. Controller
5. Purple Mainline
6. Purple Lateral Lines
7. Wiring/Control Cables.
8. Purple Control Valve Box
9. Sprinklers.
10. Any other components for a complete system.

B. Record Drawings: Contractor responsible for providing Owner with As-Built drawings of the irrigation system as installed. Show piping and major system components. Legibly mark drawings to record actual construction. Indicate horizontal and vertical locations reference to permanent surface improvements. Identify field changes of dimension and detail and changes made in the field.

C. Operation and Maintenance Data: For irrigation systems, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Procedures" include data for the following:

1. Automatic-control valves.
2. Sprinklers.
3. Controllers.

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.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver irrigation system components in manufacturer’s original undamaged and unopened containers with labels intact and legible.

B. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

A. Protect existing trees, plants lawns and other features designed to remain as part of the final landscape work.

B. Promptly notify the Landscape Architect of unexpected subsurface conditions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide only new materials without flaws or defects and of the highest quality of their specified class and kind.

B. Comply with pipe sizes indicated. No substitution of smaller pipes will be permitted. Larger sizes may be subject to acceptance of the Landscape Architect. Remove damaged and defective pipe.

C. Provide pipe continuously and permanently marked with manufacturer's name or trademark, size schedule and type of pipe, working pressure at 73 degrees F.

2.2 PIPES, TUBES, AND FITTINGS

A. Polyvinyl chloride pipe: ASTM D2241, rigid, unplasticized PVC, extruded from virgin parent material. Provide pipe homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, wrinkles and dents. See plan for type.

B. PVC pipe fittings: ASTM D2241 schedule 40 PVC molded fittings suitable for solvent weld, slip joint ring tight seal, or screwed connections. Fittings made of other materials are not permitted.

C. All pipe under paved areas will be sleeved with Schedule 40 P.V.C. The Contractor will provide a minimum of 2" Schedule 40 P.V.C. under all paved areas to produce access for electrical control wire.

2.3 VALVE BOXES

A. Plastic Valve Boxes: Box and cover, with open bottom and openings for piping; designed for installing flush with grade. Include size as required for valves and service.

1. Box: Tapered enclosure of rigid plastic material comprised of fibrous components chemically inert and unaffected by moisture corrosion and temperature changes.
2. Cover Material: Provide lid of same material, purple in color.

2.4 SPRINKLERS

A. Refer to drawing’s materials list.

1. Sprinklers: All Sprinkler heads shall be as indicated on the drawings. All sprinkler heads on risers of 12 inches or more shall be secure in plumb position using a 30 inch angle iron stake and stainless steel clamps. All risers shall be painted; color to be determined by Landscape Architect.

2.5 AUTOMATIC-CONTROL SYSTEM

A. Refer to drawing’s materials list.

1. Controller: Irrigation contractor shall furnish electric controller as indicated on the drawing. Controller shall be installed in the area shown on the drawing. Power from the electrical panel to the irrigation controller shall be furnished by others. All wiring from the irrigation controller to the remote control valves shall be furnished and installed by the irrigation contractor in the same trench as the main line.

B. Wiring: UL 493, Type UF-B multi-conductor, with solid-copper conductors and insulated cable; suitable for direct burial.

1. Wire color code: Provide control or “hot” wires red in color. Provide common or “ground” wires white in color.
2. Splicing Materials: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint and epoxy resin moisture seal; suitable for direct burial.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine final grades and installation conditions. Do not start irrigation system work until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. Layout and stake the locations of each pipe run and all sprinkler heads and sprinkler valves. Obtain Owners Representative acceptance of layout prior to excavating.

B. Schedule 40 sleeves to be used under paved vehicular use areas shall be placed prior to compaction of paved areas. Coordinate all sleeve placement with general contractor.

C. Place sleeves as indicated for installation of piping and control wire.

3.3 INSTALLATION

A. Excavating and backfilling:

1. All excavation shall be considered and unclassified excavation and include all materials encountered.
2. Excavate trenches of sufficient depth and width to permit proper handling of installation of pipe and fittings.
3. Excavate to depths required to provide 2" depth of earth fill or sand bedding for piping when rock or other unsuitable bearing materials in encountered.
4. Fill to match adjacent grade elevations with approved earth fill material. Place and compact fill in layers not greater than 8" depth.

a. Provide approved earth fill or sand to a point 4" above the top of the pipe.
b. Fill to within 6" of final grade with approved excavated fill materials free of lumps or

rocks larger than 3" in any dimension.

c. Provide clean topsoil fill free of rocks and debris for top 6" of fill.

5. Except as indicated, install irrigation mains with a minimum cover of 18" based on finished grades. Install irrigation laterals with a minimum cover of 12" based on finished grades.
6. Excavate trenches and install piping and fill during the same working day. Do not leave open trenches or partially filled trenches open overnight.
7. Replace stripped sod in sufficient time to allow for satisfactory sod recovery and growth. Water stripped and reinstalled sod until irrigation system is placed in operation.

B. Plastic pipe:

1. Install plastic pipe in accordance with manufacturer's installation instructions. Provide for thermal expansion and contraction.
2. Saw cut plastic pipe. Use a square-in-sawing vice to ensure a square cut. Remove burrs and shavings at cut ends prior to installation.
3. Make plastic to plastic joints with solvent weld joints or slip seal joints. Use only sol-vent recommended by the pipe manufacturer. Install plastic pipe fittings in accordance with pipe manufacturer's instructions. Contractor shall make arrangements with pipe manufacturer for all necessary field assistance.
4. Make plastic to metal joints with plastic male adapters.
5. Make solvent weld joints in accordance with manufacturer's recommendations.
6. Allow joints to set at last 24 hours before pressure is applied to the system.

C. Sprinklers, fittings, valves and accessories:

1. Install fittings, valves, sprinkler heads, risers and accessories in accordance with manufacturer's instructions, except as otherwise indicated.

   a. Provide concrete thrust blocks where required at fittings and valves.

2. Set sprinkler heads perpendicular to finished grades, except as otherwise indicated.
3. Obtain Landscape Architect's review and acceptance of height for proposed sprinkler heads and valves prior to installation.
4. Locate sprinkler heads to assure proper coverage of indicated areas. Do not exceed sprinkler head spacing distances indicated.
5. Install risers for spray heads in shrub or flower bed areas and planters of sufficient height to prevent interruption of the stream by the plan material.

   a. Provide risers of 1/2" PVC pipe, threaded each end.
   b. Paint exposed galvanized risers with 1 coat black paint.
   c. Set risers in a row with top level and in-line.

6. Install pop-up gear driven sprinklers with flex-pipe connected to a barbed ell.
7. Install controller as detailed.
8. Install in-ground control valves in a valve access box as indicated.
9. Install valve access boxes on a suitable base of gravel to provide a level foundation at proper grade and to provide drainage of the access box.
10. Seal threaded connections on pressure side of control valves with teflon tape or approved plastic joint type compound.

D. Control wiring.

1. Install electric control cable in the piping trenches wherever possible. Place wire in trench adjacent to pipe. Install wire with slack to allow for thermal expansion and contraction. Expansion joints in wire may be provided at 200-foot intervals by making 5-6 turns of the wire

around a piece of 1/2" pipe instead of slack. Where necessary to run wire in a separate trench, provide a minimum cover of 12".

2. Provide sufficient slack at site connections at remote control valves in control boxes and at all wire splices to allow raising the valve bonnet or splice to the surface without disconnecting the wires when repair is required.
3. Connect each remote control valve to one station of a controller except as otherwise indicated.
4. Connect remote valves to common ground wire system.
5. Make wire connections to remote control electric valves and splices of wire in the field, using wire connectors and sealing cement in accordance with manufacturer's recommendations.
6. Provide tight joints to prevent leakage of water and corrosion build-up of the joint.

E. Sleeves:

1. Provide new sleeves for all locations where existing sleeves are not indicated. Install new sleeves prior to paving installation wherever possible. Coordinate with general contractor.
2. Install pipe sleeves under existing concrete or asphalt surface by jacking, boring, or hydraulic driving of the sleeve. Remove and replace existing concrete and asphalt surfaces where cutting is necessary. Obtain Owner's permission before cutting existing concrete and asphalt surfaces. Where piping is shown under paved areas which are adjacent to turf areas, install the piping in the turf areas.

F. Flushing, testing and adjustment:

1. After sprinkler piping and risers are installed and before sprinkler heads are installed, open control valves and flush out the system with full head of water.
2. Perform system testing upon completion of each section. Make necessary repairs and retest repaired sections as required.
3. Adjust sprinklers after installation for proper and adequate distribution of the water over the coverage patter. Adjust for the proper arc of coverage.
4. Tighten nozzles on spray type sprinklers after installation. Adjust sprinkler adjusting screw on lateral line or circuit as required for proper radius. Interchange nozzles' pat-terns as directed by the Landscape Architect to give best arc of coverage.
5. Adjust all electric remote control valve flow control stems for system balance.
6. Test and demonstrate the controller by operating appropriate day, hour, and station selection features as required to automatically start and shut down irrigation cycles to accommodate plant requirements.

3.4 DISPOSAL OF WASTE MATERIALS

A. Stockpile, haul from site, and legally dispose of waste materials, including unsuitable excavated materials, rock, trash, and debris.

3.5 ACCEPTANCE

A. Test and demonstrate to the Landscape Architect and Owner the satisfactory operation of the system free of leaks. All main lines shall be hydrostatically tested at a pressure of 100 psi for a period of time not less than 3 hours. Should any leaks be found, it shall be repaired. The line shall then be retested until satisfactory.

B. Instruct the Owner's designated personnel in the operation of the system, including adjustment of sprinklers, controller(s) and valves.

C. Upon acceptance, the Owner will assume operation of the system.

3.6 GUARANTEES

A. The irrigation contractor shall furnish warranties in writing certifying that the quality and workmanship of all materials and installation furnished is in accordance with these specifications and in accordance with the original manufacturers' warranties. Irrigation contractor shall further see to the fulfillment of all manufacturers' warranties. Irrigation contractor shall warrant the installation workmanship for a period of one (1) year from date of completion of acceptance of the job or any accepted portion of the job.

3.7 CLEANING

A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, soil, debris, and equipment. Repair damage resulting from irrigation system installation.

END OF SECTION 32 84 00

SECTION 32 92 00 – SODDING

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

A. Provide sodded lawns as shown and specified. The work includes:

1. Soil preparation.
2. Sodding common areas, pavement edges, and other indicated areas.
3. Maintenance.

1.2 SUBMITTALS

A. Submit sod growers certification of grass species. Identify source location.

1.3 QUALITY ASSURANCE

A. Sod: Comply with American Sod Producers Association (ASPA) classes of sod materials.

B. Provide and pay for materials testing. Testing agency shall be acceptable to the Landscape Architect. Provide the following data:

1. Topsoil:

a. Ph factor.
b. Mechanical analysis.
c. Percentage of organic content.
d. Recommendations on type and quantity of additives required to establish satisfactory Ph factor and supply of nutrients to bring nutrients to satisfactory level for planting.

1.4 DELIVERY, STORAGE AND HANDLING

A. Cut, deliver and install sod within a 24-hour period.

1. Do not harvest or transport sod when moisture content may adversely affect sod survival.
2. Protect sod from sun, wind, and dehydration prior to installation.
3. Do not tear, stretch, or drop sod during handling and installation.

1.5 PROJECT CONDITIONS

A. Work notification: Notify Landscape Architect at least 7 working days prior to start of sodding operations.

B. Protect existing utilities, paving, and other facilities from damage caused by sodding operations.

C. Perform sodding work only after irrigation and other work affecting ground surface has been completed. The irrigation system will be installed, tested, and functional prior to sodding and sprigging. Locate, protect, and maintain the irrigation system during sodding and sprigging operations. Repair irrigation system components damaged during sodding operations at the Contractor's expense.

D. Provide hose and lawn watering equipment as required.

1.6 WARRANTY

A. Provide a uniform stand of grass by watering, mowing and maintaining lawn areas until final acceptance. Re-sod areas which fail to provide a uniform stand of grass with specified materials, until all affected areas are accepted by the Landscape Architect.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Sod: Argentine Bahia

B. Provide healthy, well-rooted, material, free of diseases, nematodes and soil borne insects. Provide sod uniform in color, leaf texture, density, and free of weeds, undesirable grasses, stones, roots, thatch, and extraneous material; viable and capable of growth and development when planted.

1. Furnish sod machine stripped and of Supplier's standard width, length, and thickness: Uniformly 1-1/2" to 2" thick with clean cut edges. Mow sod before stripping.

C. Water: Free of substance harmful to sod growth. Hoses or other methods of transportation furnished by Contractor.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine finish surfaces, grades, topsoil quality and depth. Do not start sodding work until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. Limit preparation to areas that will be immediately sodded.

B. Loosen topsoil of lawn areas to minimum depth of 2". Remove stones over 1" in any dimension and sticks, roots, rubbish, and extraneous matter.

C. Grade lawn areas to smooth, free draining and even surface with a loose, uniformly fine texture. Roll and rake; remove ridges and fill depressions as required to drain. Grade immediately before sodding. Verify grading follows engineering plans. Contractor will be responsible for regarding if sod are not placed in a timely manner and wash out or other erosion causes grades to deviate from engineering plans.

D. Dampen dry soil prior to sodding.

F. Restore prepared areas to specified condition if eroded, settled, or otherwise disturbed after fine grading and prior to sodding.

3.3 INSTALLATION

A. Sodding:

1. Lay sod to form a solid mass with tightly-fitted joints. Butt ends and sides of sod strips. Do not overlay edges. Stagger strips to offset joints in adjacent courses. Remove excess sod to avoid smothering of adjacent grass. Provide sod pad top flush with adjacent curbs, sidewalks, and drains.
2. Do not lay dormant sod or install sod on saturated soil.
3. Water sod thoroughly with a fine spray immediately after laying.
4. Roll a minimum of four (4) times with a medium weight roller to ensure contact with sub-

grade.

B. Sod indicated areas within contract limits and areas adjoining contract limits disturbed as a result of construction operations.

3.4 MAINTENANCE

A. Maintain sodded lawn areas, including watering, spot weeding, mowing, application of herbicides, fungicides, insecticides and resodding until a full, uniform stand of grass free of weed, undesirable grass species, disease, and insects is achieved and accepted by the Landscape Architect.

1. Water sod thoroughly every day, as required to establish proper rooting.
2. Repair, rework, and resod all areas that have washed out or are eroded. Replace undesirable or dead areas with new sod.
3. Mow lawn areas as soon as lawn top growth reaches a 3" height. Cut back to 2" height. Not more than 40% of grass leaf shall be removed at any single mowing.

3.5 ACCEPTANCE

A. Inspection to determine acceptance of sodded lawns will be made by Landscape Architect, upon Contractor's request. Provide notification at least 7 working days before required inspection date.

1. Sodded areas will be acceptable provided all requirements, including maintenance, have been complied with, and a healthy, even-colored viable lawn is established, free of weeds, undesirable grass species , disease and insects.

B. Upon acceptance, the Owner will assume responsibility for lawn maintenance.

C. If not accepted at the time of the inspection, the Contractor will be required to prepare a maintenance schedule for all grassed areas for the City. The City may require this maintenance schedule if construction is delayed or for any reason the City deems necessary to ensure that the grass is well maintained.

3.6 CLEANING

A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, debris and equipment. Repair damage resulting from sodding operations.

END OF SECTION 32 92 00

SECTION 32 92 01 – TURF AND GRASSES (BERMUDA)

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. This section includes the furnishing and installation of grassing materials at areas indicated on the drawings.

B. Soil preparation.

C. Soil placement and fine grading.

D. Soil testing.

E. Soil amendments as recommended by soil test results.

F. Soil treatment with pre-emergent and post-emergent herbicides.

G. Maintenance/grow-in program to include the furnishing and installation of fertilization, herbicides and insecticides and all necessary maintenance including mowing and hand weeding. Re-application of grassing materials as necessary to insure a healthy, dense, weed-free stand of grass.

H. Coordination with irrigation system installation/adjustment as shown on plans and as specified in SECTION 32 84 00 – PLANTING IRRIGATION for purposes of continued watering for turf establishment and adjustment of heads in relation to turf height to prevent head damage during mowing operations.

1.3 QUALITY ASSURANCE

A. Comply with regulations of all governing agencies when applying herbicides and pesticides. Applications shall follow manufacturer instructions.

B. Grassing shall be performed by a turf specialist knowledgeable with climate conditions and planting requirements of the geographical area and whose work has resulted in successful lawn establishment. Installer shall maintain an experienced full-time supervisor on the project site when grassing operations are in progress.

C. A.S.P.A. (American Sod Producers Association) – Guideline Specifications to Sodding.

D. Athletic Fields: Design, Construction and Maintenance by the University of Florida – Institute of Food and Agricultural Sciences (IFAS) – Bulletin #202. 2009 Pest Control Guide for Turfgrass

Managers by the University of Florida/IFAS.

E. Root zone coarse sand report: Submit analysis report for the mix specified in PART 2 – MATERIALS.

1. Before delivery of root zone coarse sand (USGA Construction Sand), furnish a soil analysis produced by a licensed qualified soil testing laboratory confirming compliance with the specified horticultural requirements. This soil analysis shall include percentages of organic matter (including, but not limited to, silt, clay and organic content) and present levels of phosphorous, potassium and acidity (pH).

2. The analysis shall also include the infiltration rate performance in inches per hour. A range of 10 to 20 inches per hour is required.

3. Provide a complete laboratory analysis of the fill placed beneath the root zone coarse sand prior to the delivery of the sand to the site. That analysis shall include particle size, ph, and percentages of sand, silt, clay and organic matter. Deliver the analysis to the Owner’s Representative, project engineer and the project landscape architect.

F. All sod specified herein shall be certified Bermuda Celebration grass. Provide sod source including name and telephone number of sod farm.

1.4 DELIVERY, STORAGE; & HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1.

B. Do not deliver more grassing materials than can be installed within 24 hours of delivery.

C. Store all chemicals off-site. Keep all pesticides, herbicides and fertilizers in a secure area when in use on-site and keep away from public.

1.5 COORDINATION

A. Coordinate work under provisions of Division 1.

B. Coordinate installation of underground sprinkler system, piping and heads.

C. Utilities: Determine location of underground utilities and perform work in a manner which will avoid possible damage. Hand excavate, as required.

1.6 JOB CONDITIONS

A. Planting time: Best to install sod during the active growing season.

B. When work on the project has progressed sufficiently to commence root zone placement and planting, then the planting operations shall be conducted only under favorable weather conditions which are normal for such work as determined by accepted sports field sodding practices.

1.7 WARRANTY

A. Provide a 60 day warranty from the date of final completion and acceptance. After a period of sixty days a warranty inspection will be performed by a certified agronomist at the expense of the contractor. The warranty inspection will be performed to determine the health of the turf

including the presence of any noxious weed growth, insect infestations, contamination by other grass species, overall color of the turf and general health.

B. If during the warranty and replacement period any of the turf is found to be damaged or destroyed due to vandalism, poor maintain practices, over-use, malicious mischief and/or vehicle rutting, then the responsibility of replacing those grass areas is not that of the Contractor.

1.8 DEFINITIONS:

A. Weeds: Includes Torpedograss, Bahiagrass, St. Augustine, Nut Sedge, Dandelion, Goosegrass, Dollar Weed, Quackgrass, Dogfennel, Horseweed or Marestail, Morning Glory, Rushes, Common Bermuda, and any other weed or grass noted in “Weeds of Southern Turfgrasses”, as published by the University of Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences.

B. Submit manufacturer data on herbicides, pesticides and fertilizers.

C. Submit maintenance/operation instructions for continuing Owner maintenance. Include seasonal cutting instructions and height, watering rates, soil amendment, fertilization, herbicide and insecticide application rates and frequencies.

PART 2 - PRODUCTS

2.1 ROOT ZONE COARSE SAND (USGA Construction Sand)

A. The contractor shall provide An 8” deep layer of root zone coarse sand, which shall be non-calcareous, clean and processed meeting the following criteria:

Size	**Sieve MESH**	**Diameter of Sieve (mm)**	**Allowable Range Percent Retained**
Gravel	10	2.00	Less than, equal to 3%
Very Coarse	18	1.00	Less than, equal to 7%
Coarse	35	0.50	At least 60% particles combined in the Coarse and Medium range
Medium	60	0.25	
Fine	100	0.15	20% maximum
Very Fine	270	0.05	5% maximum
Silt		0.002	5% maximum
Clay		Less than 0.002	3% maximum

No more than 10% including 3% fine gravel combined for sieve meshes 10 and 18. Combined fractions no more than 10% for materials less than or equal to 0.05 in size.

B. The root zone sand shall be free of any and all toxic substances, grass, roots, weeds, stones, weed seeds and insects.
C. The ph shall be between 6.0 and 6.5.
D. Organic matter shall be no more than 1%.

2.2 FERTILIZER:

A. Fertilization is specified in Section 3.1.B

2.2 HERBICIDES/INSECTICIDES/PESTICIDES/SOIL FUMIGANTS:

A. “Roundup” (Glyphosate) post-emergent herbicide, to kill emergent weeds prior to placement of root zone mix and as otherwise required.

B. Delay the use of post emergent herbicides as long as possible, and for at least the first four weeks, to allow the turf to become established. “Monument” may be used for nutsedge control.

C. “Ronstar” pre-emergent herbicide.

D. Pesticides: Sod Webworms, Mole Crickets – “Orthene”. Fire Ants: “Amdro”.

2.4 SOD

A. Sod shall be Bermuda Celebration grass. All sod shall be “Blue Tag” certified turf grass from a certified Bermuda Celebration sod grower. Any and all replacement sod required for repairs shall be from the same grower to maintain consistent color, texture and density.

1. Sod shall be strongly rooted Bermuda Celebration sod, true-to-type, high quality grass which has been propagated in a controlled cultural environment, grown on fumigated farms not less than two years old, free of noxious weeds and undesirable native grasses and machine cut to pad thickness of 1. 5” (+ 1/4") prior to cultivation, plus top growth. Provide only sod capable of vigorous growth and development when planted (not dormant).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Placement: place 8” of root zone coarse sand to achieve final elevations indicated on engineer’s grading plans.

B. Place fertilizer at a ratio of 1-2-4 (example 5/10/20 formulation). The nitrogen source shall be slow-release urea-formaldehyde applied at 1 lb. of nitrogen per 1,000 sq. ft. of turf. The starter fertilizer shall contain a basic micro-nutrient package.

C. Roto-till or mix 2” of the coarse sand to 2” of depth of soil prior to placement of final lift of 6” of coarse sand. Place the remaining 6” of coarse sand. Roto-till all areas to receive the Bermuda sod in two passes in the same direction.

D. Provide grades to the elevations indicated on the engineer’s plan. Compact to 92% of the maximum dry unit weight according to ASTM D1557.

E. Final Grading: Remove all construction debris, vegetation, roots, rocks, weeds, depressions, undulations and irregularities. Smooth the surface with a trap rake machine with drag. Apply a pre-emergent herbicide/fertilizer (15-0-15) application (Ronstar .67% Oxadiazon), per manufacturer’s instructions at the rate of 300 lbs. /acre, just prior to grassing installation.

F. Sodding: Water the field surface prior to sod placement. Sod to be installed in 48” rolls. Sod must be planted within 24 hours of harvesting. Lay sod in straight lines butted tightly together without stretching. Roll the field immediately after completion of installation to provide a level

and even playing surface. Repair any ruts caused by mechanical equipment during placement of sod rolls. Water the field heavily to wet the entire depth of sod and root zone mix. After the field has dried, hand topdress any cracks between sod caused by shrinkage. Allow four weeks for rooting prior to using the field for traffic and/or play.

1. Fertilization: After planting, new turf grass shall be fertilized as required. The nitrogen source during grow-in will be mostly water soluble (21-0-0 and 15-0-15). Potassium and nitrogen shall be added in a balanced ratio (15-0-15), alternating every seven days with 21-0-0. Apply four weekly applications of fertilizer (two 15-0-15 and two 21-0-0 at the rate .50 lbs. nitrogen/potassium/1,000 sq. ft.) for the first 30 days of grow-in. Micro nutrient sprays of iron, magnesium and manganese shall be applied to aid in turf establishment. Supplemental liquid potassium and iron (such as 0-0-28, plus iron) shall be applied every two weeks in conjunction with an insecticide application, if insects are active. Any and all granular fertilizations shall be watered-in immediately to avoid foliar turf grass burn.
2. Mowing: Use reel mowers with sharp blades. Provide first mowing when Bermuda grass reaches one inch height, just after the field has been rolled with a 2.5 ton double steel drum, then reduce the height over time until the turf grass becomes established at ¾” height. Continue to mow as long as grass clipping are observed (generally 2-3 times/week). Do not mow when the turf grass is extremely wet to avoid tire rutting.
3. Weed control: Use of post-emergent herbicides for control of grassy weeds should be discouraged and avoided the first four weeks. Certified “Blue Tag” sod is guaranteed to be weed and insect free, therefore post-emergents should not be needed. Use “Monument” to control nutsedgegrass after the initial four week grow-in period. Delay herbicide applications as long as possible to allow the turf grass to become well established. Hand pulling of weeds shall be conducted if only a few weeds are present however, if many weeds emerge, the use of selective post-emergent herbicides may be required. For the first 2-3 weeks care not to operate any heavy equipment on the newly installed sod for fear of tire rutting the field. Turf tired tractors can be used, but not on saturated soils. Apply fertilizers and pesticides on dryer fields, if at all possible initially.
4. Rolling: Sodded areas shall be rolled throughout the grow-in period to push roots into the soil, to settle or “firm” the root zone and to smooth the surface to prevent mower scalping. Weekly rolling should be performed until the eventual permanent mowing height is achieved.
5. The fields should be sand topdressed using USGA construction sand, the last week of the grow-in period.
6. The fields shall be kept insect free (sod web worms, fire ants and mole crickets) during the grow-in period.

E. Clean-up: All excess soil, grass materials, stones, and other waste shall be removed from the site daily and not allowed to accumulate. Paved areas must be kept clean at all times.

F. Grow-in maintenance: The Contractor shall provide grow-in maintenance of turf for 30 days after placement of the turf and playing fields. Maintenance shall begin immediately upon placement of the sod and shall continue until final acceptance inspection is held. Maintenance shall include watering, fertilizer applications mowing, pesticide applications, rolling, topdressing, replanting, and all other work necessary to produce a uniform, pest-free, weed-free and healthy turf playing field.

1. Irrigation: The fields shall be irrigated immediately after installation with enough water to keep the root zone mix moist at all times without being saturated. No watering shall take place at night. The contractor shall have the irrigation water tested to assure it’s acceptability for use on Bermuda sod.

3.2 GUARANTEE AND REPLACEMENT

A. Replacement of sod necessary during the 30 day grow-in maintenance period shall be the responsibility of the Contractor, except for possible replacements of sod due to theft, vandalism and neglect by Owner or acts of negligence on the part of others.

B. The 30 day guarantee period shall also include field grading and/or settlement.

3.3 FINISHING:

A. During grassing work, keep pavements clean and work area in an orderly condition at all times.

3.4 INSPECTION AND REVIEW:

A. When grass work is completed the Owner’s Representative will, upon request, make an inspection to determine acceptability to commence 30 day grow-in/guarantee period.

B. When inspected sodding work does not comply with coverage, weed-free or insect-free requirements, replace rejected work and continue specified maintenance until re-inspected by the Owner’s Representative and found to be acceptable. Remove rejected grassing materials promptly from project site.

3.5 REQUEST FOR FINAL ACCEPTANCE

A. At the end of the 30 day grow-in period the Contractor shall submit to the Owner a written request for final acceptance of the soccer field turf. The request shall be submitted at least ten days prior to the anticipated date of acceptance. A Final Acceptance inspection will be held at that time. If Final Acceptance is denied, the contractor shall utilize all methods necessary to achieve Final Acceptance.

3.6 PROTECTION:

A. Protect grassing work and materials from damage due to grassing operations, operations by other Contractors and trades and trespassers. Maintain protection during installation and maintenance periods. Protect sodded areas against damage from erosion as required. Treat, repair or replace damaged grass work as directed. Replace/repair turf areas damaged by improper use of fertilizers, herbicides, insecticides, fungicides, nematicides or other chemicals.

B. When applying herbicides, insecticides, fungicides or pesticides/nematicides coordinate use with university personnel. Post signs when chemicals are in-use or when areas are to be off limits to students or university personnel. Contractor shall assume responsibility for protecting public when chemicals are present or in use on project site.

END OF SECTION 32 92 01

SECTION 32 93 00 – LANDSCAPING

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

A. This Section includes the following:

1. Soil Preparation
2. Trees, plants, and ground covers.
3. Planting mixes.
4. Mulch and planting accessories.
5. Maintenance.

1.2 DEFINITIONS

A. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than sizes indicated; wrapped, tied, rigidly supported, and drum-laced as recommended by ANSI Z60.1.

B. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with 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 kind, type, and size of exterior plant required.

C. Finish Grade: Elevation of finished surface of planting soil.

D. Planting Soil: Native soil.

E. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

1.3 SUBMITTALS

A. Submit the following material samples:

1. Mulch
2. Planting accessories.

B. Submit certifications for the following materials:

1. Topsoil source and PH value.
2. Fertilizer

C. Material Test Reports: For existing surface soil and imported topsoil.

D. Record Drawings: Contractor responsible for providing the Owner with as-built landscape plan drawings. Legibly mark drawings to record actual construction. Indicate actual planting locations and identify any field changes to size or quantity of material.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of exterior plants.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor

on project site when landscape installation is in progress.

B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."

D. Plant names indicated comply with “Standardized Plant Names” as adopted by the latest edition of the American Joint Committee of Horticultural Nomenclature. Names of varieties not listed conform generally with names accepted by the nursery trade. Provide stock true to botanical name and legibly tagged.

E. Plant material shall be graded Florida No. 1 or better as outlined under Grades and Standards for Nursery Plans, State Plant Board of Florida.

F. All plants shall be nursery grown under climatic conditions similar to those in the locality of the project for a minimum of two years.

G. Tree and Shrub Measurements: Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 4 ½ ft. above grade for all trees. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip. Stock furnished shall be at least the minimum size indicated. Larger stock is acceptable, at no additional cost, and providing that the large plans will not be cut back to size indicated.

PART 2 – PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown trees, shrubs and ground cover complying with Florida “Grades and Standards for Nursery Plants”, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sunscald, injuries, abrasions, and disfigurement.

B. Grade: Provide trees, shrubs and ground covers of sizes and grades complying with Florida “Grades and Standards for Nursery Plants” for type of trees, shrubs and ground cover required. Trees, shrubs and ground cover of a larger size may be used if acceptable to Landscape Architect, with a proportionate increase in size of roots or balls.

C. Dig balled and burlapped plants with firm, natural balls of earth of sufficient diameter and depth to encompass the fibrous and feeding root system necessary for full recovery of the plant. Provide ball sizes complying with the latest edition of the “American Standards for Nursery Stock.” Cracked or mushroomed balls are not acceptable. Synthetic burlap is not acceptable.

D. Container-grown stock: Grown in a container for sufficient length of time for the root system to have developed to hold its soil together, firm and whole.

1. No plants shall be loose in the container.
2. Container stock shall not be pot bound

E. Provide tree species that at heights (when mature) over 25’-0” with a single main trunk. Trees that have the main trunk forming a “Y” shape are not acceptable

F. Plants planted in rows shall be matched in form.

G. The height of the trees, measured from the crown of the roots to the top of the top branch, shall not be less than the minimum size designated in the plant list.

H. No pruning wounds shall be present with a diameter of more than 1” and such wounds must show vigorous bark an all edges.

I. Shrubs and ground covers shall meet the requirements for spread and height indicated in the plant list.

1. The measurements for height shall be taken from the ground level to the average height of the top of the plant and not the longest branch.
2. Single stemmed or thin plants will not be accepted.
3. Side branches shall be generous, well twigged, and the plant as a whole well bushed to the ground.
4. Plants shall be in a moist, vigorous condition, free from dead wood, bruises or other root or branch injuries.

2.2 FERTILIZER

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: 12 percent nitrogen, 10 percent phosphorous, and 12 percent pot ash, by weight. ¼ of nitrogen in the form of nitrates, ¼ in the form of ammonia salt and ½ in the form of organic nitrogen.

2.3 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: Premium grade ‘Mini Nugget’ Pine Bark.

2.4 STAKES AND GUYS

A. Stakes for Staking: Rough-sawn, sound, new hardwood, redwood, or pressure-preservative-treated softwood, free of knots, holes, cross grain, and other defects. See construction drawings for sizes.

B. Stakes for Guying: Hardwood. See construction drawings for sizes.

C. Guy/ Staking Wire: No. 10 or 12 gauge galvanized wire.

D. Turnbuckles: Galvanized steel of size and gauge required to provide tensile strength equal to that of the wire. Turnbuckle openings shall be at least 3".

E. Staking and Guying Hose: Two-ply, reinforced garden hose not less than 1/2" inside diameter.

F. Flags: Standard surveyor's plastic flagging tape, white, 6 inches (150 mm) long.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine areas to receive landscaping for compliance with requirements and conditions affecting

installation and performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Planting shall be performed only by experienced workmen familiar with planting procedures under the supervision of a qualified supervisor.

D. Locate plants as indicted or as approved in the filed by Landscape Architect after staking by the Contractor. If obstructions are encountered that are not shown on the drawings, do not proceed with planting operations until alternate plant locations have been selected. Make minor adjustments as required.

3.3 INSTALLATION

A. Planting Pits: Excavate circular plant pits with vertical sides, except for plants specifically indicated to be planted in beds. Depth of pit shall accommodate the root system. Excavate circular pits with sides sloped inward. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation. Scarify the bottom of the pit to a depth of 4".

1. Excavate approximately three times as wide as ball diameter for balled and burlapped, container-grown or fabric bag-grown stock.
2. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.

B. Backfill all planting pits with excavated material only.

C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6-inch diameter holes into free-draining strata or to a depth of 10 feet whichever is less, and backfill with free-draining material if hardpan layer is detected.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

E. Set plant material in the planting pit to proper grade and alignment. Set plants upright, plumb, and faced to give the best appearance or relationship to each other or adjacent structure. Set plant material 2" above the finish grade. No filling will be permitted around trunks or stems. Backfill the pit with planting mixture. Do not use frozen or muddy mixtures for backfilling.

1. Space ground cover plants in accordance with indicated dimensions. Adjust spacing as necessary to evenly fill planting bed with indicated quantity of plants. Plant to within 12" of the trunks of trees and shrubs within planting bed and to within 6" of edge of bed.
2. Do not use ball and burlap planting stock if root ball is cracked or broken before or during planting operation.
3. Place planting backfill around root ball in layers, tamping to settle mix and eliminate voids and air pockets. After balled and burlapped plants are set, muddle planting backfill around bases of balls and fill all voids.

4. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of backfill soil.

F. Mulching: Apply 3-inch average thickness of organic mulch extending 12 inches beyond edge of planting pit or trench. Mulch shrub and groundcover areas immediately after planting. Do not place mulch within 3 inches of trunks or stems. Thoroughly water mulched areas. After watering, rake mulch to provide a uniform finished surface.

3.4 GUYING AND STAKING

A. Stake/guy all trees immediately after sodding/ sprigging operations and prior to acceptance. When high winds or other conditions that may affect tree survival or appearance occur, the Landscape Architect may require immediate staking/guying.

B. Stake trees under 3" caliper.

C. Guy trees over 3" caliper.

D. All work shall be acceptable to the Landscape Architect.

3.5 MAINTENANCE

A. During exterior planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged exterior planting.

C. Maintain plantings until completion and acceptance of the entire project.

D. Maintenance shall include pruning, cultivating, weeding, watering, mowing sod, and application of appropriate insecticides and fungicides necessary to maintain plants free of insects and disease.

1. Re-set settled plants to proper grade and position. Restore planting saucer and adjacent material and remove dead material.
2. Tighten and repair guy wires and stakes as required.
3. Correct defective work as soon as possible after deficiencies become apparent and weather and season permit

3.6 CLEANING

A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, soil, debris, and equipment, and legally dispose of them off Owner's property. Repair damage resulting from planting operations.

3.7 ACCEPTANCE

A. Inspection to determine acceptance of planted areas will be made by the Landscape Architect, upon Contractor's request. Provide notification at least 10 working days before requested inspection date.

1. Planted areas will be accepted provided all requirements, including maintenance, have been compiled with and plant materials are alive in a healthy and vigorous condition.

B. Upon acceptance, the Owner will assume responsibility for plant maintenance.

END OF SECTION 32 93 00