PROJECT MANUAL

Sanibel Fire and Rescue Station 172

100% Construction Documents

VOLUME 2 of 2
Divisions 21 through 32

PREPARED FOR:	Sanibel Fire and Rescue District
ISSUED:	January 05, 2024
COMMISSION NO.:	2023820

SCHENKEL SHULTZ

9510 Corkscrew Palms Circle
Estero, FL 33928
239 208 4846
SchenkelShultz.com

TITLE PAGE

Sanibel Fire and Rescue District
OWNER
2351 Palm Ridge Road
Sanibel, FL. 33957

Schenkel Shultz Architecture
ARCHITECT
9510 Corkscrew Palms Circle
Estero, FL. 33928
(239) 208-4846

TRC Worldwide Engineering, Inc.
STRUCTURAL CONSULTANT
11926 Fairway Lakes Dr.
Fort Myers, FL. 33913
(239) 939-1414

OCI Associates, Inc.
MECHANICAL / ELECTRICAL / PLUMBING / FIRE PROTECTION/ TECHNOLOGY ENGINEERS
9728 Commerce Center Court
Fort Myers, FL. 33908
(239) 454-5117

RESPEC
CIVIL
1605 Hendry Street
Fort Myers, FL. 33901
(239) 418-0691

Costal Vista Design
LANDSCAPE
2410 Palm Ridge Road
Sanibel, FL. 33957
(239) 558-4610

VOLUME-1

DIVISION 05 - METALS

DIVISION 06 - WOOD AND PLASTICS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

DIVISION 08 - OPENINGS

DIVISION 09 - FINISHES

DIVISION 10 - SPECIALTIES

DIVISION 11 - EQUIPMENT

DIVISION 12 - FURNISHINGS

DIVISION 14 - CONVEYING SYSTEMS

VOLUME-2

DIVISION 23 - HVAC SYSTEMS

DIVISION 26 - ELECTRICAL

DIVISION 27 - COMMUNICATIONS

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

DIVISION 31 - EARTHWORK

DIVISION 32 - EXTERIOR IMPROVEMENTS

END OF TABLE OF CONTENTS

Division 21

Fire Suppression Systems

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 21 01 00
GENERAL FIRE PROTECTION PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE OF DIVISION

A. Work shall include all materials, equipment and labor necessary for a complete and properly functioning mechanical installation in accordance with all applicable codes, and contract drawings and specifications. Work shall include all work specified in Division-21, FIRE PROTECTION.

B. Pay for all required licenses, fees, inspections and permits.

1.3 RELATION TO OTHER WORK

A. Work Not in Division 21: Related work not included in this division consists of requirements given in the following as may be included in the contract documents:

1. Other divisions which may include work (such as concrete, steel, painting, ceiling systems, structure and other work) related to the work of Division 21.

B. Work of Division 21: Any or all sections of Division 21 may include a paragraph or paragraphs under the heading, "Relation to other Work". Where such a paragraph is indicated and work directly related to the section is listed or described, such work shall be considered as relating directly to the indicated section. Any related work (directly related or otherwise) which may be omitted by reference from the "Relation to Other Work" paragraph of such section(s), shall be provided as necessary and required whether or not such work is included by reference. Such listing or description of related work within a section is given only as a convenience to the Contractor; omission of other related sections or described work does not in any way exclude the provision of such work.

1.4 CODES

A. Install all work in accordance with the latest edition of all applicable regulations and governing codes, including the regulations of the utility companies serving the project.

B. Where a conflict in code requirements occurs the more stringent requirement shall govern.

1.5 STANDARDS

A. All equipment and devices shall bear U.L. label.

1.6 DRAWINGS

A. Architectural and structural drawings take precedence over fire protection drawings with reference to the building construction. Fire protection drawings are diagrammatic and indicate the general arrangement and extent of work. Architectural drawings indicate more exactly the desired relationship between fire sprinkler heads, diffusers, registers, lighting fixtures, equipment, electric panels and devices, plumbing fixtures, and other items which remain exposed in the completed building. Exact locations and arrangement of materials and equipment shall be determined, with the acceptance of the Architect/Engineer, as work progresses to conform in the best possible manner with the surroundings and with the adjoining work of other trades. Where locations of equipment, devices or fixtures are controlled by architectural features, establish such locations by referring to dimensions on Architectural drawings and not by scaling drawings.

1.7 DISCREPANCIES

A. In case of differences between drawings and specifications, or where drawings and specifications are not clear or definitive, the more stringent requirement shall apply. Any such discrepancies shall be referred to Architect/Engineer for clarification and instructions.

1.8 AUXILIARIES AND ACCESSORIES

A. Include all auxiliaries and accessories for complete and properly operating systems.

1.9 INVESTIGATION OF SITE

A. Check site and existing conditions thoroughly before bidding. Advise Architect/Engineer of discrepancies or questions noted before bidding.

1.10 COORDINATION

A. Provide all required coordination and supervision where work of this division connects to or is affected by work of others.

1.11 PROVISIONS FOR OPENINGS

A. Provide all openings required for work performed under Division-21. Provide sleeves or other approved methods to allow passage of items installed under any Section of Division-21.

1.12 INTERRUPTION OF EXISTING SERVICES

A. Any interruption of existing services shall be coordinated in advance with the Owner's Representative. Shutdown time and duration of critical services shall be decided by the Owner. Contractor shall provide shutoff valves at point of tie-in to minimize downtime.

1.13 CLEANING AND PROTECTION

A. Piping: Keep the interior of the piping systems free from dirt and rubbish and other foreign matter. Thoroughly clean piping and remove all dirt, scale, oil and other foreign substances which may have accumulated during the installation process.

B. Equipment: All fire protection equipment provided shall be thoroughly cleaned of all dirt, oil, concrete, etc. Any dents, scratches or other visible blemishes shall be corrected, and the appearance of the equipment made "like new" and to the satisfaction of the Architect/Engineer.

C. Upon completion, and before final acceptance of the work, all debris, rubbish, leftover materials, tools and equipment shall be removed from the site.

D. Protection of Work Until Final Acceptance: Protect all materials and equipment from damage, entrance of dirt and construction debris from the time of installation until final acceptance. Any materials and equipment which are damaged shall be repaired to "as new" condition or replaced at the direction of the Architect/Engineer. Where factory finishes occur and damage is minor, finishes may be touched up. If, in the opinion of the Architect/Engineer the damage is excessive, factory finish shall be replaced to "new" condition.

1.14 SHOP DRAWINGS

A. Submit shop drawings for all items, services and systems included in the project.

B. Shop drawings shall clearly show the following:

1. Technical and descriptive data in detail equal to or greater than the data given in the item specification. Indicate all characteristics, special modifications and features. Where performance and characteristic data is shown on the drawings or specified, submitted data shall be provided in a degree which is both quantitatively and qualitatively equal to that specified and shown so that comparison can be made. Present data in detail equal to or greater than that given in item specification and include all weights, deflections, speeds, velocities, pressure drops, operating curves, temperature ratings, dimensions, sizes, manufacturers' names, model numbers, types of material used, operating pressures, full load amperages, starting amperages, capacities, set points, chemical compositions, certifications and endorsements, operating voltages, thicknesses, gauges and all other related information as applicable to particular item.
2. Exceptions to or deviations from the contract documents. Should Architect/Engineer accept any items having such deviations which are not clearly brought to Architect/Engineer's attention, in writing, on item submittal, then Contractor is responsible for correction of such deviations regardless of when such deviations are discovered.

C. Additional Requirements: See specific sections of the Specifications for any additional requirements.

1.15 SHOP DRAWINGS TECHNICAL INFORMATION SUBMITTALS

A. All submittals are to be submitted electronically in the form of PDF. Electronic submittal file names must be formatted with the specification section number followed by the title of the specification section. One PDF file shall be provided for each specification section that requires submittals to be provided.

B. A cover page shall have adequate space for Contractor, Subcontractor and Engineer review stamps and indicate the following minimum data:

1. Project Name
2. Project Address
3. Contractor Name
4. Subcontractor Name
5. Specification Section Number
6. Specification Section Name
7. Submittal Date

C. All shop drawings and equipment submittals shall be submitted complete based on specification division. Partial submittals of each specification section will not be accepted.

D. All submittals shall have been reviewed for compliance by the Contractor and associated subcontractor prior to submission to the Engineer. A stamp bearing the name of the reviewer and date review was completed shall be on the cover page of the submittal.

E. Submittal data shall be logically grouped based on equipment tags or like material. For submittals that contain data on multiple materials or equipment, it shall be clearly noted by equipment tag or applicable material.

F. Manufacturer's data indicating multiple options or choices shall be clearly noted as to what is applicable to the material and equipment being provided. Information not applicable should be struck through or extracted.

1.16 SHOP DRAWINGS FOR PIPING SYSTEMS

A. Shop drawings for piping systems shall be performed by the installing subcontractors. Shop drawings shall show all required maintenance and operational clearances required. Title drawings shall include identification of project and names of Architect, Engineer, Contractor, subcontractor and/or supplier, date, be numbered sequentially and shall indicate the following:

1. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.

a. Fabrication and Erection dimensions.
b. Arrangements and sectional views.
c. Necessary details, including complete information for making connections with other work.
d. Kinds of materials and finishes.
e. Descriptive names of equipment.
f. Modifications and options to standard equipment required by the contract.

B. Also provide shop drawings, using architectural reflected ceiling plans, which indicate locations of the following (to be verified by Contractor): Air distribution devices, sprinkler heads, lights, access panels, fire alarm, speakers, projectors or any system device intended to be installed in the ceiling.

C. Shop drawings shall be submitted in electronic PDF format and shall bear the review stamp from the mechanical subcontractor and general contractor / CM that it has been reviewed for compliance.

D. See specific sections of specifications for further requirements.

1.17 ELECTRONIC FILES

A. CADD files will be available on a limited basis to qualified firms at the Architect's / Engineer's prerogative. Recipients are cautioned that these files may not accurately show actual conditions as constructed. Users are responsible to verify actual field conditions. These files are not intended to be used as shop drawings.

B. Any requests for electronic files shall be preceded by processing the required electronic file release form and submitting to the Engineer for authorization. Request for electronic files should be submitted through the Contractor for submission to the Architect / Engineer.

1.18 OPERATING INSTRUCTIONS

A. Submit for checking a specific set of written operating instructions on each item which requires instructions to operate. After acceptance, insert information in each Technical Information Brochure. Refer also to other sections which may describe operating instructions.

1.19 MAINTENANCE INFORMATION

A. Submit for acceptance Maintenance Information consisting of manufacturer's printed instruction and parts lists for each major item of equipment. After acceptance, insert information in each Technical Information Brochure. Refer also to other sections which may describe maintenance.

1.20 MANUFACTURER'S CHECK-OUT

A. Check out by Manufacturer's Representative (for major items of equipment): At completion of construction and after performance verification information as above-mentioned has been gathered, submitted and accepted, provide one copy of this information to the manufacturer's representative. Work required under this section shall include having the representative examine the performance verification information, check the equipment in the field while it is operating, and sign a Check-Out Memo for record. Submit a copy of the memo on each major item of equipment for each brochure. Accepted memos shall be inserted on each brochure with the performance verification information and submittal data. Memos shall be submitted and accepted before Instruction in Operation to Owner or a request for final inspection.

1.21 SYSTEM GUARANTEE

A. The work required under Division-21 shall include a one-year guarantee. This guarantee shall be by the Contractor to the Owner to replace for the Owner any defective workmanship, equipment, or material which has been furnished under this Contract at no cost to the Owner for a period of one year from the date of acceptance of the System. This guarantee shall also include reasonable adjustments of the system required for proper operation during the guarantee period. Explain the provisions of guarantee to Owner at the "Instruction in Operation Conference".

1.22 INSTRUCTION TO OWNER

A. Submit all required items for checking one week before final inspection of the building is scheduled. When all items are accepted and placed in the proper brochures, the Contractor shall give notice in writing that he is ready to give the Owner an "Instruction in Operation Conference". After the above mentioned request is received the Contractor will be notified of the time the conference can be held with the Owner. At the conference, the Contractor shall review with the Owner all appropriate information. At the end of the conference, seven copies of a memo certifying Instruction in Operation and Completed Demonstration shall be signed by the Contractor, Subcontractor and Owner and one copy inserted in each brochure.

1.23 MATERIALS AND EQUIPMENT

A. Each bidder represents that his bid is based upon the materials and equipment described in this division of the specifications.

1. Submittal shall include the name of the material or equipment for which it is to be substituted, substituted equipment model numbers, drawings, cuts, performance and test data and any other data or information necessary for the Architect/Engineer to determine that the equipment meets all specification and requirements. If the Architect/Engineer accepts any proposed substitutions, such acceptance will be set forth in writing.
2. Substituted equipment with all accessories installed or optional equipment where permitted and accepted, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether accepted or not, shall be replaced at the Contractor's expense. Any modifications of related systems of this or other trades as a result of substitutions shall be made at the Contractor's expense, and Contractor shall so state in his written request for substitution.

B. Acceptable Manufacturers: Materials and Equipment specified in these contract documents are accepted only in regard to general performance and quality. It shall be the Contractor's responsibility to ensure that acceptable materials and equipment meet or exceed the efficiencies, capacities, electrical characteristics, performance and quality of the equipment herein specified. Acceptable equipment must also generally conform, without extensive modification of related systems to the accessories, weights, space and maintenance requirements, etc., of the specified equipment. Any modification to related systems of this or other trades shall be made at the Contractor's expense and the Contractor shall be responsible for coordination between trades. Any difference in capacity, efficiency, electrical characteristics, weights or quality of product, etc., between specified materials and equipment and acceptable alternates shall be submitted to the Architect/Engineer for acceptance within 30 days of Notice to Proceed.

C. If no prior approval for substitutions or alternate manufacturers have been provided, the bid must conform with the requirements of the plans and specifications. No equipment substitutions or alternate manufacturers will be considered once the project bidding has ended.

END OF SECTION 21 01 00

SECTION 21 05 17
SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.
4. Silicone sealants.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.

B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.

C. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, with plain ends and integral welded waterstop collar.

D. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

E. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.

2.2 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.
4. Metraflex Company (The).
5. Proco Products, Inc.

B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: High-temperature-silicone interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: Stainless steel.
5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, Use NT.

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

a. Dow Corning Corporation.
b. GE Construction Sealants; Momentive Performance Materials Inc.
c. Polymeric Systems, Inc.
d. Schnee-Morehead, Inc., an ITW company.
e. Sherwin-Williams Company (The).

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

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

    a. May National Associates, Inc.; a subsidiary of Sika Corporation.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves.
b. Piping NPS 6 and Larger: Steel pipe sleeves.

2. Exterior Concrete Walls below Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves.
b. Piping NPS 6 and Larger: Steel pipe sleeves.

5. Interior Partitions:

a. Piping Smaller Than NPS 6: Steel pipe sleeves.

b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

END OF SECTION 21 05 17

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 21 05 18
ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.
k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 21 05 18

SECTION 21 05 23
GENERAL-DUTY VALVES FOR FIRE PROTECTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Iron butterfly valves with indicators.
2. Check valves.
3. Iron OS&Y gate valves.
4. NRS gate valves.
5. Indicator posts.
6. Trim and drain valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:

1. Main Level: HAMV - Fire Main Equipment.

a. Level 1: HCBZ - Indicator Posts, Gate Valve.
b. Level 1: HLOT - Valves.

1) Level 3: HLUG - Ball Valves, System Control.
2) Level 3: HLXS - Butterfly Valves.
3) Level 3: HMER - Check Valves.
4) Level 3: HMRZ - Gate Valves.

2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.

a. Level 1: VQGU - Valves, Trim and Drain.

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:

1. Automated Sprinkler Systems:

a. Indicator posts.

b. Valves.

1) Gate valves.
2) Check valves.

a) Single check valves.

3) Miscellaneous valves.

C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.

D. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B1.20.1 for threads for threaded-end valves.
3. ASME B31.9 for building services piping valves.

E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

F. NFPA Compliance: Comply with NFPA 24 for valves.

G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.

H. Valve Sizes: Same as upstream piping unless otherwise indicated.

I. Valve Actuator Types:

1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.2 IRON BUTTERFLY VALVES WITH INDICATORS

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

1. Anvil International.
2. Fivalco Inc.
3. Globe Fire Sprinkler Corporation.
4. Kennedy Valve Company; a division of McWane, Inc.
5. NIBCO INC.
6. Tyco Fire Products LP.
7. Victaulic Company.
8. Zurn Industries, LLC.

B. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig and 300 psig.
3. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, or polyamide coating.
4. Seat Material: EPDM.

5. Stem: Stainless steel.
6. Disc: Ductile iron, nickel plated and EPDM or SBR coated.
7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.
9. Body Design: Grooved-end connections.

2.3 CHECK VALVES

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

1. Anvil International.
2. Fire Protection Products, Inc.
3. Fivalco Inc.
4. Globe Fire Sprinkler Corporation.
5. Kennedy Valve Company; a division of McWane, Inc.
6. Matco-Norca.
7. Mueller Co.
8. NIBCO INC.
9. Reliable Automatic Sprinkler Co., Inc. (The).
10. Shurjoint Piping Products USA Inc.
11. Tyco Fire Products LP.
12. United Brass Works, Inc.
13. Venus Fire Protection Ltd.
14. Victaulic Company.
15. Viking Corporation.
16. WATTS.
17. Wilson & Cousins Inc.
18. Zurn Industries, LLC.

B. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig and 300 psig.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.4 IRON OS&Y GATE VALVES

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

1. American Cast Iron Pipe Company.
2. Clow Valve Company; a subsidiary of McWane, Inc.
3. Hammond Valve.
4. Kennedy Valve Company; a division of McWane, Inc.
5. Mueller Co.
6. NIBCO INC.

7. Victaulic Company.
8. WATTS.
9. Zurn Industries, LLC.

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged.

2.5 NRS GATE VALVES

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

1. American Cast Iron Pipe Company.
2. Clow Valve Company; a subsidiary of McWane, Inc.
3. Kennedy Valve Company; a division of McWane, Inc.
4. Mueller Co.
5. NIBCO INC.
6. Victaulic Company.
7. Zurn Industries, LLC.

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged.

2.6 TRIM AND DRAIN VALVES

A. Angle Valves:

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

a. Fire Protection Products, Inc.
b. NIBCO INC.
c. United Brass Works, Inc.

2. Description:

a. Pressure Rating: 175 psig and 300 psig.
b. Body Material: Brass or bronze.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

A. Comply with requirements in the following Sections for specific valve installation requirements and applications:

1. Section 21 13 13 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the pipe center.

F. Install valves in position to allow full stem movement.

G. Install valve tags. Comply with requirements in Section 21 05 53 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

END OF SECTION 21 05 23

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 21 05 29
HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fastener systems.
4. Equipment supports.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication and installation details and include calculations.

C. Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria. Submit with shop drawings for review and approval.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators according to "2015 ASME Boiler and Pressure Vessel Code, Section IX."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. NFPA Compliance: Comply with NFPA 13.

D. UL Compliance: Comply with UL 203.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
2. Galvanized Metallic Coatings: Pregalvanized or hot-dip galvanized.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.3 TRAPEZE PIPE HANGERS

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

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: NFPA-approved, UL-listed, or FM-approved threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

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

a. Hilti, Inc.
b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
c. MKT Fastening, LLC.
d. Simpson Strong-Tie Co., Inc.

B. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

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

a. B-line, an Eaton business.
b. Empire Tool and Manufacturing Co., Inc.
c. Hilti, Inc.

d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
e. MKT Fastening, LLC.

2. Indoor Applications: Zinc-coated or stainless steel.
3. Outdoor Applications: Stainless steel.

2.5 EQUIPMENT SUPPORTS

A. Description: NFPA-approved, UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.6 MATERIALS

A. Aluminum: ASTM B 221.

B. Carbon Steel: ASTM A 1011/A 1011M.

C. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A 240/A 240M.

E. Grout: ASTM C 1107/C 1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Install in accordance with approvals and listings.
2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.

D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

F. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.

G. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A 780/A 780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use stainless-steel pipe hangers and corrosion-resistant attachments for hostile environment applications.

G. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 if little or no insulation is required.
3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

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

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

I. Hanger-Rod Attachments: Comply with NFPA requirements.

J. Building Attachments: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. C-Clamps (MSS Type 23): For structural shapes.
3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

K. Comply with NFPA requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

L. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 21 05 29

SECTION 21 05 53
IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Stainless steel, 0.025 inch thick, with predrilled holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. 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.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. 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.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

D. 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) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.

B. Letter Color: Red.

C. Background Color: White.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

E. 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.

F. Fasteners: Stainless-steel rivets or self-tapping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

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

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

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; pipe size; 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.

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 LABEL INSTALLATION

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

D. Locate equipment labels where accessible and visible.

E. Piping Color-Coding: Refer to Architectural drawings for painting of piping specified.

F. Pipe-Label Locations: 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. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

END OF SECTION 21 05 53

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 21 13 13
WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Fire-department connections.
4. Sprinklers.
5. Alarm devices.
6. Pressure gages.

1.2 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.3 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

B. Design: Submit shop drawings for review and approval utilizing outlined design criteria.

1. Fire protection system contractor shall be responsible for the design of shop drawings and performing hydraulic calculations. Contractor shall provide all work customarily included if not specifically called for on the plans.

C. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Sprinkler Occupancy Hazard Classifications:

a. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
b. General Storage Areas: Ordinary Hazard, Group 1.
c. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
d. Public Areas, Bunks, and Classrooms: Light Hazard.
e. Apparatus Bay: Ordinary Hazard, Group I.
f. Elevator Shafts: Ordinary Hazard, Group II.
g. Decon Room: Ordinary Hazard, Group II.

2. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.

c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.

3. Maximum Protection Area per Sprinkler: Per UL listing.
4. Maximum Protection Area per Sprinkler:

a. Light Hazard: 225 sq. ft..
b. Ordinary Hazard: 130 sq. ft..
c. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:

a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
b. Ordinary-Hazard Occupancies: 250 gpm for 60 minutes.

1.4 SUBMITTALS

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

B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria. Installing contractor shall submit shop drawing and calculations for review and approval.

D. Qualification Data: For qualified Installer and professional engineer.

E. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations.

F. Welding certificates.

G. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

H. Field quality-control reports.

I. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."
2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

A. Piping (sizes 2” or smaller) schedule 40, ASTM A-135

B. Piping (sizes 2-1/2” or larger) E.R.W. schedule 10 black steel, ASTM A-135, grade B.

C. Piping (sizes 2-1/2” or larger) seamless schedule 10 black steel, ASTM A-795, grade B.

D. Threadable thin wall piping is not acceptable.

E. Flexible sprinkler piping is not acceptable.

F. Cast Iron Threaded Fittings: ANSI B16.4, class 125, standard pattern for threaded joints. Threads shall conform to ANSI B1.20.1.

G. Malleable Iron Fittings: ANSI B16.3, class 300, standard pattern for threaded joints. Threads shall conform to ANSI B1.20.1.

H. Steel Fittings: ASTM A-234 seamless or welded, for welded joints.

I. Grooved Mechanical Fittings: ASTM A-536, grade 65-45-12 ductile iron; ASTM A-47, grade 32510 malleable iron; or ASTM A-53, types F or types E or S, grade B fabrication steel fittings with grooves or shoulders designed to accept grooved end couplings.

J. Grooved Mechanical Couplings: Consist of ductile or malleable iron housing, a synthetic rubber gasket or a central cavity pressure-response design; with nuts, bolts, locking pin, locking toggle, or lugs to secure roll grooved pipe and fittings. Grooved mechanical couplings including gaskets used on dry pipe systems shall be listed for dry pipe service.

K. Cast Iron Flanged: ANSI B16.1, class 125, faced and drilled per American National Standard. Dimensions shall conform to WW-F-406.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.

1. Class 125, Cast-Iron Flat-Face Flanges: Full-face gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 LISTED FIRE-PROTECTION VALVES

A. General Requirements:

1. Valves shall be UL listed and FM approved.
2. Minimum Pressure Rating: 175 psig.

B. Check Valves:

1. Screwed check: 2” and smaller 200 pounds screwed bronze Y-pattern swing check bronze disc, Nibco No. KT-403, Central model –Y.
2. Flanged check: 2-1/2” and larger, 175 pounds flanged body swing check, bronze set Nibco No. F-908-WS, Stockham No. G-939, Mueller No. A-2120-6.
3. Wafer Check: 4” and larger, 250 pounds cast iron body, elastomer seal and spring loaded clapper, Central Model B, Reliable C.
4. Grooved check: 2-1/2” and larger, 250 pounds cast iron body, elastomer seal and spring loaded clapper, Central Model 90, Grinnel Model F514.
5. Riser Check: 2-1/2” and larger, 250 pounds cast iron body, resilient elastomer seal, spring loaded clapper with trim. Central Model 90, Reliable Model G.

C. OS&Y Gate Valves:

1. 2” and smaller: 175 pounds threaded iron body, bronze trim solid wedge disc, Nibco No. T-104-0, Stockham No. B -133.
2. 2-1/2” and larger: 175 pounds flanged iron body, bronze trim solid wedge disc, Mueller No. A-2052-5, Nibco No. F-607-OTS, Stockham No. G634.

D. Indicating-Type Butterfly Valves:

1. Wafer: 2-1/2” and larger: 175 pounds, outside indicating, slow close type, with UL listed dual supervisory switches. Central Model – A, Grinnell Series 8000FP.
2. Grooved: 2-1/2” and larger: 175 pounds, outside indicating slow close type, grooved ends, UL listed dual supervisory switches. Central Model BVF, Grinnell Series 7700FP.

E. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing and "Approval Guide," published by FM Global, listing.

2. Minimum Pressure Rating: 175 psig.

F. Ball Valves:

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

a. Anvil International, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Fire Protection Products, Inc.
d. FNW.
e. Kennedy Valve; a division of McWane, Inc.
f. Legend Valve.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Red-White Valve Corporation.
j. Stewart, M. A. and Sons Ltd.
k. Tyco Fire & Building Products LP.
l. Victaulic Company.

2.5 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing and "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Automatic Air Release Valve:

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

a. Tyco Fire & Building Products LP.

2. Standard: UL 2573.
3. Type: Manual or Automatic electrically supervised.
4. Components: Ball Valve, Single-pole, double-throw switch with normally closed contacts.
5. Design: Reduces trapped air in pressurized system. Install at highest point of system on main or highest portion of system. Do not obstruct sprinkler spray patterns. Locate on top of pipe. Electronic supervision is required to notify when valve is in other than fully open position.

C. Automatic (Ball Drip) Drain Valves:

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

a. AFAC Inc.
b. Reliable Automatic Sprinkler Co., Inc.
c. Tyco Fire & Building Products LP.

2. Standard: UL 1726.
3. Pressure Rating: 175 psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

2.6 FIRE-DEPARTMENT CONNECTIONS

A. Free Standing-Type, Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Elkhart Brass Mfg. Company, Inc.
    b. Guardian Fire Equipment, Inc.
    c. Potter Roemer.
    d. Fire-End & Croker Corporation.

3. Standard: UL 405.
4. Type: Free Standing Type.
5. Pressure Rating: 175 psig minimum.
6. Body Material: Corrosion-resistant metal.
7. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
8. Caps: Brass, lugged type, with gasket and chain.
9. Escutcheon Plate: Rectangular, brass, wall type.
10. Outlet: With pipe threads.
11. Number of Inlets: Two.
12. Escutcheon Plate Marking: Similar to "AUTO SPKR."
13. Finish: Polished chrome plated.
14. Outlet Size: 2-1/2 inch.

2.7 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

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

    a. Anvil International, Inc.
    b. Shurjoint Piping Products.
    c. Tyco Fire & Building Products LP.
    d. Victaulic Company.

2. Standard: UL 213.
3. Pressure Rating: 175 psig.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-T and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.

7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Sprinkler Inspector's Test Fittings:

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

   a. AGF Manufacturing Inc.
   b. Triple R Specialty.
   c. Tyco Fire & Building Products LP.
   d. Victaulic Company.
   e. Viking Corporation.

2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

2.8 SPRINKLERS

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

1. Tyco Fire & Building Products LP.

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Commercial Applications: UL 199.
2. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Finishes:

1. See plans for sprinkler head schedule.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: See plans for sprinkler head schedule.
2. Sidewall Mounting: See plans for sprinkler head schedule.

F. Sprinkler Guards:

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

a. Tyco Fire & Building Products LP.

2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.9 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm:

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

a. Tyco Fire & Building Products LP.
b. Victaulic Company.
c. Viking Corporation.

2. Standard: UL 753.
3. Type: Mechanically operated, with Pelton wheel.
4. Alarm Gong: Cast aluminum with red-enamel factory finish.
5. Size: 10-inch diameter.
6. Components: Shaft length, bearings, and sleeve to suit wall construction.
7. Inlet: NPS 3/4.
8. Outlet: NPS 1 drain connection.

C. Water-Flow Indicators:

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

a. Vane.

2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

D. Valve Supervisory Switches:

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

a. Fire-Lite Alarms, Inc.; a Honeywell company.

b. Kennedy Valve; a division of McWane, Inc.
c. Potter Electric Signal Company.
d. System Sensor; a Honeywell company.

2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

2.10 PRESSURE GAGES

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

1. AMETEK; U.S. Gauge Division.
2. Ashcroft, Inc.
3. Brecco Corporation.
4. WIKA Instrument Corporation.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gage Range: 0 to 250 psig minimum.

E. Water System Piping Gage: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 SERVICE-ENTRANCE PIPING

A. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

J. Install alarm devices in piping systems.

K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

M. Install air release valve at the highest possible location in the sprinkler system. Open the air release valve prior to filling the system with water to allow for as much air as possible to escape the system before closing.

N. Fill sprinkler system piping with water.

O. Install sleeves for piping penetrations of walls, ceilings, and floors.

P. Install sleeve seals for piping penetrations of concrete walls and slabs.

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 18 "Escutcheons for Fire-Suppression Piping."

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3.5 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

3.6 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install free standing, fire-department connections.

B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.7 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.10 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
3. Schedule 40, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Schedule 40, galvanized-steel pipe with roll-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 8, shall be one of the following:

1. Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
2. Schedule 10, galvanized-steel pipe with roll-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.11 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers; see drawings for type.
2. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers as indicated. See drawings for type
3. Wall Mounting: Sidewall sprinklers; see drawings for type.
4. Spaces Subject to Freezing: See drawings for type.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: See drawings.
2. Recessed Sprinklers: See drawings.
3. Upright, Pendent, and Sidewall Sprinklers: See drawings.

END OF SECTION 21 13 13

THIS PAGE INTENTIONALLY LEFT BLANK

Division 22

Plumbing

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 22 00 01
PLUMBING, GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE OF DIVISION

A. Work shall include all materials, equipment and labor necessary for a complete and properly functioning mechanical installation in accordance with all applicable codes, and contract drawings and specifications. Work shall include all work specified in Division-22 PLUMBING.

B. Pay for all required licenses, fees, inspections and permits.

C. The work pertaining to this Division occurs within the confines of the building line, and within a boundary outside of the building line for a distance of five (5) feet, measured normal to the building line, or as indicated on the drawings.

D. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders", "substitutions", and other similar provisions.

1.3 RELATION TO OTHER WORK

A. Work Not in Division-22: Related work not included in this division consists of requirements given in the following as may be included in the contract documents:

1. Other divisions which may include work (such as concrete, steel, painting, ceiling systems, structure and other work) related to the work of Division-22.

B. Work of Division-22: Any or all sections of Division-22 may include a paragraph or paragraphs under the heading, "Relation to other Work". Where such a paragraph is indicated and work directly related to the section is listed or described, such work shall be considered as relating directly to the indicated section. Any related work (directly related or otherwise) which may be omitted by reference from the "Relation to Other Work" paragraph of such section(s), shall be provided as necessary and required whether or not such work is included by reference. Such listing or description of related work within a section is given only as a convenience to the Contractor; omission of other related sections or described work does not in any way exclude the provision of such work.

1.4 CODES

A. Install all work in accordance with the latest edition of all applicable regulations and governing codes, including the regulations of the utility companies serving the project.

B. Where a conflict in code requirements occurs the more stringent requirement shall govern.

1.5 STANDARDS

A. All equipment and devices shall bear U.L. label, the label of an industry recognized approved testing agency or A.G.A. certification for said item of equipment or device.

B. All electrical devices must be U.L. approved.

1.6 DRAWINGS

A. Architectural and structural drawings take precedence over mechanical drawings with reference to the building construction. Mechanical drawings are diagrammatic and indicate the general arrangement and extent of work. Architectural drawings indicate more exactly the desired relationship between diffusers, registers, lighting fixtures, equipment, electric panels and devices, plumbing fixtures, and other items which remain exposed in the completed building. Exact locations and arrangement of materials and equipment shall be determined, with the acceptance of the Architect/Engineer, as work progresses to conform in the best possible manner with the surroundings and with the adjoining work of other trades. Where locations of equipment, devices or fixtures are controlled by architectural features, establish such locations by referring to dimensions on Architectural drawings and not by scaling drawings.

1.7 DISCREPANCIES

A. In case of differences between drawings and specifications, or where drawings and specifications are not clear or definite, the subject shall be referred to Architect/Engineer for clarification and instructions.

1.8 ELECTRICAL PROVISIONS

A. Work of Division 22 includes various electrical requirements (a) which incorporate specific electrical features and components which are required to be physically integral with mechanical equipment, or (b) which require necessary electrical interconnecting components for the mechanical systems. Such electrical-related work to be provided as work of Division 23 includes (but is not necessarily limited to) the following:

1. Motors integral with the mechanical equipment.
2. Motor starters (controllers) integral with the mechanical equipment.
3. Electrical heating coils and similar elements integral with mechanical equipment.
4. Electrical work specified in Division 23 for the HVAC control system.
5. Drip pans to protect electrical work.

B. Drip Pans: Where possible, do not run mechanical piping directly above electrical (or electronic) equipment which is sensitive to moisture; otherwise provide drip pans under mechanical piping. Locate pan below piping, and extend 6" on each side of piping and lengthwise 18" beyond equipment. Fabricate pans 2" deep, of reinforced sheet metal with rolled edges and soldered or welded seams; 20 gage copper, or 16 gage steel with 2 oz. zinc finish hot dipped after fabrication. Provide 3/4" copper drainage piping, properly discharged.

C. Motors: Unless specifically specified otherwise in the section covering the driven equipment (or the equipment drives), motors shall comply with the following:

1. Three Phase: NEMA design B, three-phase, squirrel cage induction type designed for 1800 rpm synchronous speed for operation in 40°C ambient at 1.15 service factor at

constant speed on the scheduled voltage. Motors shall be insulated with Class B insulation material and shall be cast iron, drip proof, horizontal foot mounted type with ball bearings. Two speed motors shall be provided as scheduled and shall be two winding type.

2. Single Phase: Squirrel cage induction type designed for 1800 rpm synchronous speed for operation in 40ºC ambient at 1.15 service factor at constant speed on the scheduled voltage. Motors shall be insulated with Class B insulation materials and shall be two winding capacitor start type with steel enclosure, drip proof, horizontal foot mount and ball bearings.
3. Electric motors which are designated to be high efficiency type shall also comply with the section describing high efficiency motors.
4. Manufacturer: Electric motors, complying with the requirements of this Section and the installation and performance requirements of the plans, by the following manufacturers are acceptable:

    a. Reliance Electric
    b. Gould Electric
    c. General Electric
    d. Westinghouse

D. Scheduled Horsepower: The horsepowers scheduled or specified are those nominal sizes estimated to be required by the equipment when operating at specified duties and efficiencies. In the case of pumps, these horsepowers are non-overloading and may also include provisions for future planned impeller changes. If the actual horsepower for the equipment furnished differs from that specified or shown on the drawings, it shall be the Contractor's responsibility to insure that proper size feeders, breakers, starters, etc. are provided at no change in contract price.

E. Any TEFC motors shall have Class F insulation.

F. Drip proof protected motors shall have Class B insulation.

1.9 COORDINATION BETWEEN DIVISION 22 AND DIVISION 26 OF WORK RELATED TO POWER AND CONTROL REQUIREMENTS

A. Definitions: Definitions for the purpose of mechanical/electrical control and power coordination are as given below. Any items which do not fall within the scope of this paragraph shall be coordinated as individually specified.

1. "Furnish" means to procure an item and to deliver it to the project for installation.
2. "Install" means to determine (in coordination with others as necessary) the appropriate intended location of an item and to set and connect it in place.
3. "Provide" means to both furnish and install.
4. Power Circuit: Circuit which carries main electric power to apparatus to which the power circuit is connected.
5. Control Circuit: Circuit which carries electrical signals directing the performance of a controller but which does not carry the main electric power. (See NEC, Section 430-71.) Such circuits shall also include those which serve a dual control and power function (e.g., a line voltage thermostat circuit which both activates and powers a small fan motor).
6. Controller: A device, or group of devices, which serves to govern, in some predetermined manner, electric power delivered to apparatus to which the controller is connected and includes any switch or device normally used to start and stop a motor. (See NEC, Article 100, Definitions, "Controller", and Section 430-81(a).)
7. Control Device: A device which reacts to an operating condition (pressure, temperature, flow, humidity, etc.) and which initiates transmission of an electrical control signal which causes operation of a controller or which causes operation of pressure switches, etc.

8. Auxiliary Control Device: A device (such as a low voltage control transformer, electric relay, etc.) which is located in a control circuit and which carries or responds to (but does not initiate) an electrical control signal initiated by a control device.

B. Work of Division-22 includes (but is not necessarily limited to):

1. Provide:

a. All controllers which are generally manufactured or shipped as integral with Division-22 equipment.
b. All electric motors and other electrical power consuming equipment (such as electric boilers, electric hot water heaters, etc.) which are specified in Division-22.
c. All control circuits (including conduit and boxes) from the Division-26 panels to point of use including the necessary circuit breakers.
d. All other control circuits, including conduit and boxes.
e. All control connections to equipment.
f. All control connections to controllers, switches, motors and other mechanical systems electrical power consuming equipment (such as electric air heating coils, electric boilers, electric hot water heaters, etc.).
g. Auxiliary control devices.
h. All control devices (thermostats, pressure switches, flow switches, humidistats, etc.) and make control circuit connections thereto.
i. Any and all electronic and electric control devices and electric or pneumatic connections thereto.

2. Furnish:

a. All controllers which are generally manufactured and/or shipped as separate but companion items to Division-22 equipment.

C. Work of Division-26 includes (but is not necessarily limited to):

1. Provide:

a. All power circuits, including conduit and boxes.
b. All power connections to controllers, switches, motors and other mechanical systems electrical power consuming equipment (such as electric air heating coils, electric boilers, electric hot water heaters, etc.).
c. All remote motor disconnects (remote from the related controller) at all locations required by NEC and connections thereto except those disconnects which are specified in Division-22 to be provided as part of the equipment itself.
d. All controllers (except those which are generally manufactured or shipped as separate but companion items to Division-22 equipment.

2. Install:

a. All controllers which are generally manufactured and/or shipped as separate but companion items to Division-22 equipment.

1.10 AUXILIARIES AND ACCESSORIES

A. Include all auxiliaries and accessories for complete and properly operating systems.

1.1 COORDINATION

A. Provide all required coordination and supervision where work of this division interfaces directly or indirectly with work of any other divisions.

1.2 PROVISIONS FOR OPENINGS

A. Provide all openings required for work of Division-22. Provide sleeves or other approved methods to allow passage of items installed under any Section of Division-22.

1.1 CLEANING AND PROTECTION

A. Equipment: All mechanical equipment provided shall be thoroughly cleaned of all dirt, oil, concrete, etc. Any dents, scratches or other visible blemishes shall be corrected and the appearance of the equipment made "like new" and to the satisfaction of the Architect/Engineer.

B. Upon completion, and before final acceptance of the work, all debris, rubbish, leftover materials, tools and equipment shall be removed from the site.

C. Protection of Work Until Final Acceptance: Protect all materials and equipment from damage, entrance of dirt and construction debris from the time of installation until final acceptance. Any materials and equipment which are damaged shall be repaired to "as new" condition or replaced at the direction of the Architect/Engineer. Where factory finishes occur and damage is minor, finishes may be touched up. If, in the opinion of the Architect/Engineer the damage is excessive, factory finish shall be replaced to "new" condition.

1.2 SHOP DRAWINGS

A. Submit shop drawings for all Division 22 work including all items, services and systems provided for the project.

B. Shop drawings for each of the following groups shall be submitted as a single submission for that particular group. Submission of more than one group as a single submission is encouraged.

1. All plumbing work.
2. All plumbing insulation work.

C. Provide a shop drawing submission schedule for all Division 22 work to the Architect/Engineer for approval. Allow sufficient time in making shop drawing submission to provide for Architect/Engineer=s review, rejection, resubmission, rejection and resubmission without creating project construction delays of any type. Consider that Architect/Engineer will require not less than 10 working days for the submittal to be in the possession of the reviewing design professional for review and comment for each submission.

D. Shop drawings shall clearly show the following:

1. Technical and descriptive data in detail equal to or greater than the data given in the item specification. Indicate all characteristics, special modifications and features. Where performance and characteristic data is shown on the drawings or specified, submitted data shall be provided in a degree which is both quantitatively and qualitatively equal to that specified and shown so that comparison can be made. Present data in detail equal to or greater than that given in item specification and include all weights, deflections, speeds,

velocities, pressure drops, operating temperatures, operating curves, temperature ranges, sound ratings, dimensions, sizes, manufacturers' names, model numbers, types of material used, operating pressures, full load amperages, starting amperages, fouling factors, capacities, set points, chemical compositions, certifications and endorsements, operating voltages, thicknesses, gauges and all other related information as applicable to particular item.

2. Exceptions to or deviations from the contract documents. Should Architect/Engineer accept any items having such deviations which are not clearly brought to Architect/Engineer's attention, in writing, on item submittal, then Contractor is responsible for correction of such deviations regardless of when such deviations are discovered.

E. Additional Requirements: See specific sections of the Specifications for any additional requirements.

1.3 SHOP DRAWINGS TECHNICAL INFORMATION BROCHURE

A. All submittals are to be submitted electronically in the form of PDF. Electronic submittal file names must be formatted with the specification section number followed by the title of the specification section. One file shall be provided for each specification section that requires submittals to be provided.

B. A cover page shall have adequate space for Contractor, Subcontractor and Engineer review stamps and indicate the following minimum data:

1. Project Name
2. Project Address
3. Contractor Name
4. Subcontractor Name
5. Specification Section Number
6. Specification Section Name
7. Submittal Date

C. All shop drawings and equipment submittals shall be submitted complete based on specification division. Partial submittals of each specification section will not be accepted.

D. All submittals shall have been reviewed for compliance by the Contractor and associated subcontractor prior to submission to the Engineer. A stamp bearing the name of the reviewer and date review was completed shall be on the cover page of the submittal.

E. Submittal data shall be logically grouped based on equipment tags or like material. For submittals that contain data on multiple materials or equipment, it shall be clearly noted by equipment tag or applicable material.

F. Manufacturer’s data indicating multiple options or choices shall be clearly noted as to what is applicable to the material and equipment being provided. Information not applicable should be struck through or extracted.

1.1 SHOP DRAWINGS FOR PIPING SYSTEMS

A. Shop drawings for piping systems and duct systems shall be of sufficient scale to verify clearances and equipment locations. Shop drawings shall show all required maintenance and operational clearances required. Cost of shop drawing preparation and reproduction shall be borne by the Contractor. Title drawings shall include identification of project and names of

Architect, Engineer, Contractor, subcontractor and/or supplier, date, be numbered sequentially and shall indicate the following:

1. Architectural and structural (as required) backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.

    a. Fabrication and Erection dimensions.
    b. Arrangements and sectional views.
    c. Necessary details, including complete information for making connections with other work.
    d. Kinds of materials and finishes.
    e. Descriptive names of equipment.
    f. Modifications and options to standard equipment required by the contract.
    g. Leave blank area, size approximately 4 by 2-1/2 inches, near title block (for Engineer's shop drawing stamp imprint).

B. In order to facilitate review of drawings, insofar as practicable, they shall be noted, indicating by cross reference the contract drawings, note, and/or specification paragraph numbers where item(s) occur in the contract documents.

C. See specific sections of specifications for further requirements.

1.20 ELECTRONIC FILES

A. CADD files and REVIT will be available on a limited basis to the contractors. Recipients are cautioned that these files may not accurately show actual conditions as constructed. Users are responsible to verify actual field conditions. These files are not intended to be used as shop drawings.

1. A request for electronic drawing files should be delivered in writing along with the Engineer of Record drawing release form by the for such files. Files will not be processed until a signed release form is received.

1.21 OPERATING INSTRUCTIONS

A. Submit for checking a specific set of written operating instructions on each item which requires instructions to operate. After acceptance, insert information in each Technical Information Document. Refer also to other sections which may describe operating instructions.

1.22 MAINTENANCE INFORMATION

A. Submit for acceptance Maintenance Information consisting of manufacturer's printed instruction and parts lists for each major item of equipment. After acceptance, insert information in each Technical Information Document. Refer also to other sections which may describe maintenance.

1.23 MANUFACTURER'S CHECK-OUT

A. Check out by Manufacturer's Representative (for major items of equipment): At completion of construction and after performance verification information as above-mentioned has been gathered, submitted and accepted, provide one copy of this information to the manufacturer's representative. Work required under this section shall include having the representative

examine the performance verification information, check the equipment in the field while it is operating, and sign a Check-Out Memo for record. Submit a copy of the memo on each major item of equipment for each brochure. Accepted memos shall be inserted on each brochure with the performance verification information and submittal data. Memos shall be submitted and accepted before Instruction in Operation to Owner or a request for final inspection.

1.24 SYSTEM GUARANTEE

A. The work required under Division-22 shall include a one year guarantee. This guarantee shall be by the Contractor to the Owner to replace for the Owner any defective workmanship, equipment, or material which has been furnished under this Contract at no cost to the Owner for a period of one year from the date of acceptance of the System. This guarantee shall also include reasonable adjustments of the system required for proper operation during the guarantee period. Explain the provisions of guarantee to Owner at the "Instruction in Operation Conference".

1.25 INSTRUCTION TO OWNER

A. Submit all required items for checking one week before final inspection of the building is scheduled. When all items are accepted and placed in the proper brochures, the Contractor shall give notice in writing that he is ready to give the Owner an "Instruction in Operation Conference". After the above mentioned request is received the Contractor will be notified of the time the conference can be held with the Owner. At the conference, the Contractor shall review with the Owner all appropriate information. At the end of the conference, seven copies of a memo certifying Instruction in Operation and Completed Demonstration shall be signed by the Contractor, Subcontractor and Owner and one copy inserted in each brochure.

1.26 MATERIALS AND EQUIPMENT

A. Each bidder represents that his bid is based upon the materials and equipment described in this division of the specifications.

1. Submittal shall include the name of the material or equipment for which it is to be substituted, substituted equipment model numbers, drawings, cuts, performance and test data and any other data or information necessary for the Architect/Engineer to determine that the equipment meets all specification and requirements. If the Architect/Engineer accepts any proposed substitutions, such acceptance will be set forth in writing.
2. Substituted equipment with all accessories installed or optional equipment where permitted and accepted, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether accepted or not, shall be replaced at the Contractor's expense. Any modifications of related systems of this or other trades as a result of substitutions shall be made at the Contractor's expense, and Contractor shall so state in his written request for substitution.

1.27 ACCEPTABLE MANUFACTURERS

A. Acceptable Manufacturers: Materials and Equipment specified in these contract documents are accepted only in regard to general performance and quality. It shall be the Contractor's responsibility to insure that acceptable materials and equipment meet or exceed the efficiencies, capacities, electrical characteristics, performance and quality of the equipment herein specified. Acceptable equipment must also generally conform, without extensive modification of related systems to the accessories, weights, space and maintenance

requirements, etc., of the specified equipment. Any modification to related systems of this or other trades shall be made at the Contractor's expense and the Contractor shall be responsible for coordination between trades. Any difference in capacity, efficiency, electrical characteristics, weights or quality of product, etc., between specified materials and equipment and acceptable alternates shall be submitted to the Architect/Engineer for acceptance within 30 days of Notice to Proceed.

PART 2 - PRODUCTS

2.1 PIPING SPECIALTIES

A. Where it is desirable or necessary to support the pipe hangers to concrete, inserts shall be placed in the forms by the Mechanical Contractor prior to the time concrete is poured.

B. Lead tamp-ins may be used when installed in a concrete or masonry wall or other like vertical surface to support a vertical hanger. Lead tamp-ins will not be permitted to support hangers to the underside of concrete slab.

C. For parallel runs of above ground suspended piping, an acceptable trapeze-type hanger may be used. Provide permanent, non-conductive type wrapping between copper pipe and steel trapeze hangers.

D. Pipes passing through walls, floors shall have sleeves of the same materials as the pipe. Sleeves shall allow insulated pipes to pass without changing the insulation thickness. Clearance around sleeves shall be packed with glass fiber after completion of pipe work. Sleeves in all floor slabs except slabs on grade shall have pipe sleeves extended 1 inch above finish floor to prevent water from running through sleeves to area below. Make watertight, caulk with sealant around each sleeve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The contractor shall furnish all labor, materials, *including gases* equipment and instruments required to conduct tests of piping systems. Tests shall be as herein called for.

B. PVC piping, fittings and other PVC materials shall not be installed in air conditioning plenums or equipment rooms used as air conditioning plenums.

C. Tests shall be conducted and the inspection of the piping shall be made in the presence of the Architect and/or Engineers.

D. Material and/or joints found defective shall be replaced and/or corrected and additional tests shall be conducted after correction of work.

3.2 PIPE SIZING, DRAWINGS AND SPECIFICATIONS

A. It is intended that work covered by these specifications and drawings include everything requisite and necessary to make the various systems complete and operative, irrespective of whether or not every item is specifically provided for. Any omission of direct reference herein to any essential item shall not excuse contractor from complying with the above intent.

B. Figured dimensions supercede scaled ones. Contractor shall take no advantage of and shall promptly call the Owner's Representative's attention to any error, omission or inconsistency in specifications and drawings.

C. Special attention is directed to requirements that equipment and materials stated in specifications and/or indicated on drawings shall be furnished, except if otherwise noted, completely installed, adjusted and left in safe and satisfactory operating condition. Accessories, appliances and connections necessary for operation of equipment shall be provided to satisfaction of the Owner's Representative.

D. Materials, apparatus or equipment specified or otherwise provided for on drawings, addenda, or change orders issued subsequent to award of contract shall be same brand, type, quality and character originally specified unless otherwise provided.

E. Layout of equipment, accessories, specialties and suspended, concealed or exposed piping systems are diagrammatic unless dimensioned. In preparing shop drawings, contractor shall check project conditions before installing work. If there are any interferences or conflicts, they shall be called to attention of the Owner's Representative immediately for clarification.

F. The drawings indicate required size and points of termination of pipes and ducts and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the work of this contractor to make the installation in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further obstruction or cost to the Owner.

G. Shop drawings shall be furnished by this contractor, indicating all changes to meet space requirements, code requirements and as necessary to resolve all space conflicts.

H. It is intended that all apparatus be located symmetrical with architectural elements and shall be installed at exact height and locations as shown on the architectural drawings. Refer to architectural details in completing and correlating work.

I. The contractor shall fully inform himself regarding any and all peculiarities and limitations of the spaces available for the installation of all work and materials furnished and installed under the contract, prior to submitting his bid. He shall exercise due and particular caution to determine that all parts of his work are made quickly and easily accessible.

J. It cannot be too strongly emphasized that, except for work specifically excluded herein, every system shall be turned over to Owner installed completed, with components, ready for normal operation.

K. Pipe sizes shall be minimum as allowed by local codes or as shown on the drawings, whichever is larger.

END OF SECTION 22 00 01

SECTION 22 05 23
VALVES, COCKS, AND SPECIALTIES FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Furnish and install valves, cocks and specialties as indicated on drawings or specified herein.

B. Valves, cocks and specialties may not be indicated in every instance on the drawings, but whether or not shown, all valves, cocks and check valves necessary to the proper operation of the system shall be furnished and installed by subcontractor in an approved manner and location. Pressure ratings given for valves are steam working pressure. Valves shall have rising stems except in locations where space is limited; in these locations non-rising stem valves of equal material and pressure class will be accepted.

C. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders", "substitutions", and other similar provisions.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.4 SUBMITTALS

A. Submit manufacturer's data for review before any work is commenced.

2.1 WATER MAIN VALVES

A. Water main valves are to be AWWA approved, gate valve, double disc, iron body, bronze trim, non-rising stem, flanged end, with 2 inch square wrench nut. Valve boxes are to be cast iron adjustable type for top flush with ground surface. Furnish a box for each underground valve shown on drawings.

Valves	Valve Boxes
Mueller No. A2380-6	Alabama Pipe Co. E2602
Stockham Fig. G-745	James B. Clow F2450
Crane No. 462	Mueller H10360

2.2 BALL VALVES

A. 3 inches and smaller: Threaded or soldered ends, port area equal to or greater than connecting pipe diameter, class 125, two piece bronze body, bronze ball, bronze stem, teflon seat and seals. Acceptable manufacturers: Milwaukee Model UPBA475B; (Crane, Hammond, Jamesbury, Nibco, Stockham, and Walworth. *Basis of Design is Milwaukee Valve Company.*

2.3 GATE VALVES (THREADED)

A. 2 inches and smaller threaded valves and 4 inches and smaller solder pattern valves, rising stem, iron wheel, rough brass or bronze body, solid wedge disc, screwed or union bonnet and finished gland nut - 150 psi class. *Basis of Design is Milwaukee Valve Company.*

Threaded Pattern	Soldered Pattern
Crane 431	- - -
Milwaukee	UP115
Stockham B-122	B-124

2.4 CHECK VALVES (SWING)

A. Check valves 3 inches and smaller shall have a pressure rating of not less than 200 psi threaded pattern and 125 psi solder pattern, wye pattern swing check with rough brass body, finished gland nut and regrinding bronze disc. Basis of Design is Milwaukee Valve Company. Model UPC967/968.

2.5 COCKS

A. Provide tight shut off balancing cocks at locations indicated on drawings.

B. Cocks 2 inches and smaller, square head bronze cocks 125 psi class with check.

Crane 254
Powell 955
Milwaukee

2.6 BUTTERFLY VALVES

A. Butterfly valves may be used in lieu of gate valves or throttling valves when indicated on the drawings or in potable water systems pipe sizes 4 inches and above.

1. Design working pressure and temperature 150 psig and 180^{o}F.
2. Materials of construction:

a. Body: Malleable or ductile iron
b. Disc: Aluminum bronze
c. Stem: 416 stainless steel
d. Bushings: Bronze
e. Seat: Compound 230 Buna N or as per manufacturer's recommendation for specific service.
f. Handle: Lever lock through 10 inch size, if valve is to be used for throttling service, provide infinite adjustment throttle plate.

B. Valves used for the isolation of equipment or for future connections shall have flanged ends or flange unions to permit removal of equipment and/or piping with the valve remaining in service.

C. Acceptable manufacturers are Milwaukee Valve Company; Keystone, Center Line or Demco. Basis of Design is Milwaukee Valve Company. Model ML334E.

2.7 BACK FLOW PREVENTER (REDUCED PRESSURE)

A. ¾ inch to 4-inch size; ASSE Std. 1013, AWWA Std. C-506; unit shall have all bronze construction, stainless steel internal parts, test cocks and suitable for 175 psi supply water pressure. Unit shall be furnished with factory mounted bronze inlet strainer, union and non-rising stem gate/ball valves (on inlet and outlet). Watts or Zurn-Wilkins are acceptable.

2.8 BACK FLOW PREVENTER (DOUBLE CHECK VALVE)

A. ¾ inch to 2-inch; ASSE Std 1015, AWWA Std. C-506; unit shall have bronze body, stainless steel internal parts, test cocks and rubber seating check valves. Unit shall be furnished with factory mounted bronze inlet strainer, union, and non-rising stem gate or ball valves (on inlet or outlet). Watts or Zurn-Wilkins are acceptable.

2.9 DIELECTRIC UNIONS

A. Epco Sales, Inc., 3204 Sackett Avenue, Cleveland, Ohio; Capitol Manufacturing & Supply Company, Columbus; Patrol Valve Company, Cleveland, Ohio, or approved equal.

2.10 FLEXIBLE METAL HOSE

A. American Brass Co., Mason Industries, Chicago Metal Hose Co., or approved equal, 300 psig WP design flexible metal hose constructed of brass with brass wire braid covering.

2.11 FLEXIBLE PLASTIC PIPE JOINTS

A. Resist-O-Flex Co., Mercer Rubber Co., La Favorite Co., or approved equal, multiple bellows, guides, and restraining bolts or blocking. Joints shall be rated at 150 psig and 220°F continuous service.

2.12 COPPER PIPING SYSTEM STRAINERS

A. Copper piping system strainers solder pattern with removable bolted flange on strainer leg. Strainer 40 mesh bronze screen, with free area of screen at least 3 times cross sectional area of pipe.

2.13 ACCESS PANELS

A. Access panels (Milcor) Inland-Ryerson Construction Products Co., (Boico) Birmingham Ornamental Iron Co., or approved equal. Steel panels and frames shall be furnished with prime coat of rust inhibitor enamel. See plans for sizes (12 x 12) min.). Access panel styles as follows:

	Milco	Boico
Fire rated	1-1/2 hr. B. Label	1-1/2 hr. B. Label

2.14 SAFETY VALVES

A. Safety Valves to be Manning, Maxwell & Moore, Watts Regulator, or Bell & Gossett Co., ASME rated as shown on the drawings and/or required by applicable codes.

2.15 AUTOMATIC AIR VENTS (AAV)

A. Automatic Air Vents to be equal to:

(150 psig W.P)	(75 psig W.P)
Metraflex MV-15	Maid-O-Mist 7
Crane Co. 976	Bell & Gossett 7
Sarco 13W	Hoffman 79
Armstrong 1AV	

2.16 MANUAL AIR VENTS (MAV)

A. Manual air vents shall be brass manual cock equal to Crane 700 series.

2.17 WASHER AND ICE MAKER BOXES

A. Provide washing machine and ice maker box assembles with integral shutoff valves and arrestors. Sioux Chief Washer Box 696-2313MF for residential washing machines. Sioux Chief Ice Maker Box; Sioux Chief 696-1010MF.

2.18 WATER HAMMER ARRESTERS

A. Water hammer arresters shall be equal to those manufactured by Josam Manufacturing Company, Sioux Chief, Zurn Industries, Inc., Wade, Inc., MIFAB or Jay R. Smith Manufacturing Company.

B. Water hammer/shock arrestors shall be selected and approved for use without the need for access panels. Sioux Chief Model “HydraRester” or approved equal.

2.19 ICE MACHINE WATER FILTRATION SYSTEM

A. Provide ice maker single filtration system water filter assembly as manufactured by Everpure Insurice/Pentair. Model #PF-i2000 Filtration system (EV9324-21). Include one complete set of spare pre-filter cartridge (EC210) and i2000 replacement cartridge (EV9612-22).

2.20 WATER HOSE REEL ASSEMBLY

A. Provide Model Number 15500 (3/4”) Heavy-Duty Hose Reel Assembly with 75 feet of water hose and quick connect coupling.

PART 3 - EXECUTION

3.1 GENERAL

A. Install valves and cocks in horizontal piping with the valve stem in the vertical upright position.

B. All valves installed in hot and hot water re-circulating systems shall include valve extension stems to clear the piping insulation thickness, no exceptions.

C. Install valves and cocks to provide adequate clearance to permit easy operation of the valve hand wheel and permit servicing of the valve packing.

D. ALL ISOLATION VALVES LOCATED ABOVE THE CEILING SHALL BE INSTALLED FOR DIRECT ACCESS AT A MAXIMUM OF 12 INCHES ABOVE THE CEILING.

3.2 ACCESS PANELS

A. Furnish adequate number of properly sized access panels (12 inch x 12 inch minimum size) to adequately service and maintain systems installed under each section of specifications.

B. Access panels shall be installed and painted under other divisions of these specifications. Exact panel location shall be designated by the subcontractor performing the work of this Section.

C. Access panels are not required in exposed grid or other types of readily removable ceilings.

D. Access panels shall not compromise the fire rating of the wall.

E. Plumbing contractor is responsible for providing all access panels for accessing plumbing valves and components above hard ceiling areas.

3.3 SAFETY VALVES

A. Safety valves to have valve spindle enclosure with gland seal to minimize leakage and manual lift lever to check discharge required. Cut discharge pipe from safety valve on a 45 degree angle, pipe to floor and direct toward or into floor drain (unless noted otherwise on the drawings).

3.4 AUTOMATIC AIR VENTS

A. Install automatic air vents with inlet isolation cock at locations indicated on drawings and at high points of hot and chilled water piping systems. Pipe vent discharge to drain pan, plumbing trap or to outside of building.

3.5 WATER HAMMER ARRESTERS

A. Install water hammer arresters shall be provided and located in accordance with the FPC 2010 and in accordance with size and placement recommendations given in Plumbing and Drainage Institute Standard PDI-WH201.

3.6 WATER FILTRATION SYSTEM

A. Install filtration system for ease of access/maintenance and in accordance with the manufacturer's instructions. Provide ¾-inch inlet/outlet ball valves for isolation purposes. Provide final runout to the ice machine water supply connection.

3.7 BACKFLOW PREVENTERS

A. Water service back flow preventers shall be installed above grade and in such a manner to prevent the discharge relief opening from becoming submerged by ground water. Provide suitable protection to prevent assembly from freezing.

END OF SECTION 22 05 23

SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING, VALVES AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

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

    a. Brady Corporation.
    b. Brimar Industries, Inc.
    c. Carlton Industries, LP.
    d. Champion America.
    e. Craftmark Pipe Markers.
    f. emedco.
    g. Kolbi Pipe Marker Co.
    h. LEM Products Inc.
    i. Marking Services, Inc.
    j. Seton Identification Products.

2. Material and Thickness: Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
3. Letter Color: Black.
4. Background Color: Yellow.
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-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

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

   a. Brady Corporation.
   b. Brimar Industries, Inc.
   c. Carlton Industries, LP.
   d. Champion America.
   e. Craftmark Pipe Markers.
   f. emedco.
   g. Kolbi Pipe Marker Co.
   h. LEM Products Inc.
   i. Marking Services, Inc.
   j. Seton Identification Products.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
3. Letter Color: Black.
4. Background Color: Yellow.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
7. 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-quarters the size of principal lettering.
8. Fasteners: Stainless-steel rivets.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

D. 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) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Craftmark Pipe Markers.
6. emedco.
7. LEM Products Inc.
8. Marking Sevices Inc.
9. National Marker Company.

10. Seton Identification Products.
11. Stranco, Inc.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

C. Letter Color: Black.

D. Background Color: Yellow.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. 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-quarters the size of principal lettering.

H. Fasteners: Stainless-steel rivets.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

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

1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.
5. Champion America.
6. Craftmark Pipe Markers.
7. emedco.
8. Kolbi Pipe Marker Co.
9. LEM Products Inc.
10. Marking Sevices Inc.
11. Seton Identification Products.

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

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

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Valve Tags: Each tag shall designate appropriate service and valve number. Be securely attached with meter seals with 4-ply 0.018 copper smooth wire, or brass "S" hooks, or brass jack chain in a manner to allow easy reading. Provide either of the following types:

1. Brass Type: Minimum 19 gauge polished brass; 1-1/2" min. diameter. Acceptable: Seton Style 250-BL or equivalent.
2. Aluminum Color Coded Type: Anodized aluminum; 2": min. diameter. Acceptable: Seton Style 2070 or equivalent.
3. Aluminum Alloy Type: 16 gauge sheet aluminum: depressed type letters filled with black enamel. Face and periphery of satin finish Alumilite, Alcoa 204A2 or equal, free from burns and scratches. Seton Type 4 or equivalent.
4. Fiber Glass Type: 1/16" thick glass fiber reinforced resin. 2" x 2" size of 2-1/2" x 9" size as necessary to identify item. Brady Series No. 2297 or equivalent.

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size 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: Size letters according to ASME A13.1 for piping.

PART 3 - EXECUTION

3.1 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.2 PIPE LABEL INSTALLATION

A. Piping Color Coding: Painting of piping is specified in Architectural drawings and/or specifications.

B. Pipe Label Locations: 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 and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

1. Domestic Water Piping

a. Background: Safety green.

b. Letter Colors: White.

2. Sanitary Waste and Storm Drainage Piping:

a. Background Color: Safety black.
b. Letter Color: White.

3. Compressed Air Piping:

a. Background Color: Safety blue.
b. Letter Color: White.

4. LP Gas Piping:

a. Background Color: Yellow.
b. Letter Color: White.

3.3 VALVE TAGS

A. Valve tags shall be installed on the following items:

1. All manual valves which perform functions other than isolation of an equipment item for servicing. This includes, but is not limited to, valves in valve stations, remote locations where use is not evident due to proximity of equipment or other piping, and similar locations.
2. Small piping (other than domestic water) where markers are impractical.
3. Small but critical equipment items on which it is impractical to install labels.

3.4 VALVE TAG LISTS

A. Prior to substantial completion, provide a complete list of all valves having tags. Indicate the following on such list:

1. Valve size.
2. Valve location.
3. Valve type.
4. Service application.
5. Valve manufacturer and model number.
6. Pressure class and allowable working pressure.

END OF SECTION 22 05 53

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 22 07 00
INSULATION FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division-01 Specification Sections, apply to work of this section.

1.2 SCOPE

A. Waste lines receiving condensate from air conditioning units to a point of connection to a soil line receiving waste from 4 or more plumbing fixtures.

B. Domestic hot water and hot water re-circulating piping.

C. Drains receiving cold water condensate and indirect cold water waste from ice machines.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division-22 and to all other applicable portions of the Drawings and Specifications.

1.4 SUBMITTALS

A. Submit manufacturer's data for review before any work is commenced.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials listed in subsequent paragraphs of this specification are those used as basis of design; alternate manufacturer's equivalent projects as listed herein will be accepted. The insulation contractor shall verify materials and comply with requirements of NFPA 90, with regard to a flame spread rating of 25 or less and; a smoke developed/fuel contributed value of less than 50.

2.2 MATERIALS

A. Insulation and accessory materials to be as manufactured by the listed manufacturers or approved equal:

1. Fiberglass: Owens Corning, Knauf, CertainTeed, or Manville.

2. Mastics, Sealers and Adhesives:

	Benjamin Foster	Insulcoustic	Childers	J-M
General purpose mastic	35-00 Series Vi AC		CP-10	375
Vapor barrier sealant (indoor)	30-35	IC-501	CP-30	
Adhesive	85-20		CP-89	
Fire retardant sealer (outdoor)	60-35	IC-531		
Extruded Poly-Ethylene	Therma-Cel 950 Adhesive			

3. Pipe Jacketing and Valve Covers (Ultra Violet Resistant): Zeston PVC, CEEL-Tite, Proto Corp. (Lo Smoke), or approved equal.
4. Metal Jacketing and Fitting Cover: Aluminum 0.016 gage (minimum) smooth or corrugated, Childers Products Co., General Aluminum Supply Co. (Gasco), Alcorjac by Insulcoustic Co., or approved equal.
5. Molded Fiberglass Fitting Insulation: Molded Acoustical Products, Inc., West Easton, PA, 18042 or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Insulation is not to be installed until the piping systems have been checked and found free of all leaks. Surfaces shall be clean and dry before attempting to apply insulation. A professional insulator with adequate experience and ability shall install insulation.

B. Provide hanger or pipe support shields of 16 gage (minimum) galvanized steel over or embedded in the insulation. Shield shall extend halfway up the pipe insulation cover and at least 6 inches on each side of the hanger. Securely fasten shield with pipe straps at each end. Insulate pipe anchors adequately to prevent moisture condensation problems.

C. Insulation installed in exposed locations such as water heater rooms, equipment rooms, air handling unit rooms, all exterior above grade areas, kitchens, laundries, power houses, utility buildings, energy building or similarly identified locations where the insulation would be subject to physical damage shall be covered with metal jacketing. Elbows may be covered with fire rated and ozone resistant (for exterior locations) PVC covers in lieu of metal jacket.

3.2 COLD SURFACES

A. Cold surfaces with operating temperatures below 70 degrees F to be insulated with 1 inch thickness foamed plastic or extruded polyethylene insulation. Surfaces include, but not limited to, domestic water chiller, domestic chilled water air separator, domestic chilled water expansion tank, domestic chilled water pump, and refrigerant suction line intercooler. The

foamed plastic sheets shall be applied over a heavy coating of Johns-Manville #57 adhesive. The insulation shall be finished with a heavy coat of white aerotube finish.

3.3 DOMESTIC HOT WATER/HOT WATER RE-CIRCULATING PIPING

A. Shall be insulated with 1 inch thickness fiberglass pipe insulation up to pipe sizes including 1-1/2" diameter. For piping diameters over 1-1/2" insulate with 1-1/2" thick fiberglass insulation. Prior to installing with insulation the pressure release paper shall be removed from the jacket laps. Pipe insulation shall be secured in place by applying pressure to the pressure sensitive closure system. Elbows shall be insulated with fiberglass inserted into 25/50 rated PVC fitting covers.

3.4 HORIZONTAL WASTE PIPING RECEIVING AIR-CONDITIONING CONDENSATE

A. Shall be insulated with 1-inch thickness AP-T fiberglass pipe insulation. Prior to installing with insulation, the pressure release paper shall be removed from the jacket laps. The insulation shall be secured in place by applying pressure to the pressure sensitive closure system. All fittings shall be insulated with pipe insulation segments and finished with Foster's 30-35 vapor barrier coating or equal, reinforced with white open weave glass fabric.

3.5 CONDENSATE PIPING FROM ICE MACHINES

A. Insulate condensate piping and waste lines from ice machines with elastomeric insulation, one-half inch thickness.

B. Mitre cut insulation to fit the pipe fittings. Use approved cement to seal all joints, seams, and ends in the insulation.

3.6 STORM WATER PIPING

A. Shall be insulated with 1" thickness fiberglass pipe insulation. Prior to installing with insulation the pressure release paper shall be removed from the jacket laps. Pipe insulation shall be secured in place by applying pressure to the pressure sensitive closure system. Elbows shall be insulated with fiberglass inserted into 25/50 rated PVC fitting covers.

B. Insulation shall begin at the base of roof drain body and continue until piping penetrates grade level. (Complete for sound attenuation).

3.7 HANDICAP LAVATORY EXPOSED WATER AND WASTE PIPING

A. Shall be insulated with a pre-fabricated insulation kit for the water and waste piping, one-half inch thickness.

B. Mitre cut insulation to fit the pipe, fittings and stops.

C. Use approved cement to seal all joints, seams, and end in the insulation.

END OF SECTION 22 07 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 22 11 19
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. The work pertaining to this Division occurs within the confines of the building line.

B. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders", "substitutions", and other similar provisions.

C. Water piping includes all make-up water piping and all domestic cold, hot and hot water re-circulating piping and fittings for the project.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.4 SUBMITTALS

A. Submit manufacturer's data for review before any work is commenced.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide specialties as specified under additional Sections of this Specification.

2.2 PIPE

A. The following schedule covers materials unless otherwise specified under a particular System Section.

1. Copper tube, Type L, hard drawn, ASTM B 88. (Aboveground)
2. Copper tube, Type K, hard drawn, ASTM B 88. (Below Ground)

2.3 FITTINGS

A. Copper Tube: Wrought or cast brass solder joint.

B. The 'T' drill extruded fitting method may not be used.

C. Service material shall be brass compression fittings-angle ball cocks, ball corporations, etc. Flared fittings are acceptable under controlled conditions.

D. The Viega “Pro-Press” fitting method may be used aboveground.

2.4 PIPE JOINTS

A. Joints in copper piping shall be made with tin-antimony solder (95-5) and non-acid flux. Contractor shall furnish manufacturers literature documenting that the lead content (trace quantities) are within the guidelines of the local codes having jurisdiction as well as the Safe Drinking Water Act Amendment (SDWAA).

B. Joints in threaded piping shall be made with teflon tape or non-hardening pipe compound (seal-tite).

PART 3 - EXECUTION

3.1 GENERAL

A. The design drawings are generally diagrammatic. They do not show every bend, off-set, elbow or other fitting which may be required in the piping for installation in the space allotted. Careful coordination of the work is necessary to avoid conflicts.

B. Run all water lines parallel or perpendicular to building lines.

C. For piping requiring insulation, lay out and carefully install piping with sufficient clearances to permit proper application of the insulation. If the piping is such that a neat insulation job cannot be obtained with reasonable effort, the piping subcontractor shall relocate piping.

D. Place color coded 6" wide 0.004" thickness polyethylene printed plastic identification tape directly above all underground piping systems approximately 12" below finished grade. Tapes shall be continuously printed with "CAUTION" in large bold letters. Printed second line with type of service below. Yellow tape is to be used for water, (Print type of water on tape; i.e., domestic cold water.)

3.2 HANGERS AND SUPPORTS

A. Vertical Piping shall be supported at its base and no greater than every story height.

B. Horizontal Piping (Suspended) shall be supported at not more than eight (8) foot intervals. Supports shall be adequate to maintain alignment and prevent sagging.

C. Supports shall be connected to the building structure not from other equipment, ducts or conduits.

3.3 JOINTING PIPE

A. All pipe lines shall be correctly aligned before joints are made.

B. Squarely cut pipe and properly ream to remove all constriction and burrs before making up the joints.

C. Threaded Pipe: Ream all pipe after cutting and before threading. Use non-hardening pipe compound or tape on male threads only at each joint and tighten joint to leave not more than 3 threads exposed.

D. Copper Tube: Ream all pipe after cutting squarely, clean outside of tube ends and inside of fittings and tin end to be soldered. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.

E. Provide nipples of same material and weight as pipe used. Provide extra strong nipples when length of unthreaded part of standard weight nipple is less than 1-1/2".

F. Run water supply main to point indicated on plans.

3.4 AIR CHAMBERS

A. 20 pipe diameters, but not less than 12". Provide at each, riser and ends of cold water and hot water supply lines. Water hammer arrestors may be substituted in lieu of air chambers.

3.5 WATER HAMMER ARRESTERS

A. Water hammer arresters shall be installed at the locations on the plans, at all quick-closing valves (i.e. flush valves, kitchen solenoid operated valves, etc.) and in accordance with PDI Standard WH-201. Water hammer arrestors shall be provided without requiring access panels. Provide Sioux Chief Model “Hydra-Rester” or equal.

3.6 VALVES

A. Provide bronze ball valves to isolate each riser, and branch line.

B. Provide drain valves at the base of each plumbing riser.

C. Install isolation valves above the ceiling in locations where they can easily be accessed ***(no higher than 12 inches above the ceiling)*** for service, use and maintenance. Provide hard plastic laminate I.D. tags on the ceiling grid directly below valves above lay-in ceilings. Provide hinged access doors for valves above hard ceilings. Access door quantities are not identified on the drawings but are required to be provided per the specifications and coordinated for the project.

3.7 REDUCERS

A. Screwed bushings are prohibited, except where available space prevents use of reducing couplings. Pipe reductions on horizontal, hot water piping shall be made with eccentric reducers. Top of hot water piping shall be flat for venting.

3.8 TESTS

A. Apply a water pressure test to all parts of the water supply system before the piping is concealed and before the fixtures and equipment are connected. Use a hydrostatic pressure of not less than 100 psig or 150% of system operating pressure, applied to the system for a period of four hours. There shall be no leaks at any point in the system at this pressure.

B. Leave concealed work uncovered until required tests have been completed, but if necessary, make tests on portions of the work and those portions of the work may be concealed after being inspected and approved. Make repairs of defects that are discovered as a result of inspection or tests with new materials. Caulking, welding or other such sealing methods of screwed joints, cracks or holes will not be accepted. Repeat tests after defects have been eliminated.

C. Complete all field testing prior to insulation, wrapping and/or backfill.

3.9 STERILIZATION

A. As soon as the water piping has been thoroughly flushed out, sterilize the lines by introducing into them a solution of calcium hypochlorite or chloride of lime. Open and close all valves while system is being chlorinated. After the sterilizing agent has been applied for 24 hours, test for residual chlorine at the ends of the lines. If less than 10 parts per million is indicated, repeat the process. When tests show at least 10 parts per million of residual chlorine, flush out the system until all traces of the chemical used are removed. Make necessary connections to sterilized piping.

3.10 PIPE PROTECTION

A. Wrap pipe that touches metal or is exposed to masonry with a layer of 6 mil polyethylene film or 15 lb. felt.

B. ***Install underground copper piping (Type K) in a schedule 40 PVC pipe sleeve with elbows at each and seal both ends watertight.***

END OF SECTION 22 11 19

SECTION 22 13 16
SANITARY SEWER AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. The work pertaining to this Division occurs within the confines of the building line, and within a boundary outside of the building line for a distance of five (5) feet, measured normal to the building line, or as indicated on the drawings.

B. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders", "substitutions", and other similar provisions.

C. Piping included as part of this specification includes sanitary DWV piping above/ below grade and car wash system waste/reclaim piping as indicated on the car wash manufacturer’s drawings.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.4 SUBMITTALS

A. Submit manufacturer's data for review before any work is commenced.

PART 2 - PRODUCTS

2.1 MATERIAL

A. The following schedule covers materials unless otherwise specified under a particular System Section.

2.2 PIPE

A. Cast-iron soil pipe service weight, centrifugally cast, ANSI A112.5.1. 2" Through 15" size, bell and spigot joint.

B. Cast-iron soil pipe service weight, centrifugally cast, ANSI A112.5.1. 1-1/2" through 10" size, "non-hub" joint.

C. Copper type DWV.

D. Brass pipe or tube, chrome plated.

E. PVC Type DWV, Schedule 40, ASTM D2665-78.

F. PVC Type DWV, Schedule 80, ASTM D2665-78.

2.3 FITTINGS

A. Cast-Iron Soil Pipe:

1. Underground (Grease): Provide fittings of same weight and manufacture as pipe in which installed. Joints shall be bell and spigot push-on type neoprene gasket or "NO HUB" type conforming to CIPI Standard 301 unless noted otherwise on drawings.
2. Above ground and in buildings: "NO-HUB" type conforming to CIPI Standard 301 unless noted otherwise on the drawings.

B. Threaded Drainage Pipe: Cast-iron, recessed.

C. Copper DWV: Cast or wrought solder joint DWV drainage fittings.

D. PVC Type DWV: ASTM D-2665, NSF Seal of Approval, Solvent-cement joint. Acceptable for use above and below ground except for grease piping drainage and laboratory waste from the lab sinks/fume hood cup sinks to the neutralization device.

2.4 PIPE JOINTS

A. Bell and spigot type joint shall be made with push-on compression type, neoprene gasket conforming to ASTM A-74.

B. No-hub type joints shall be constructed of 24 gage type 304 stainless steel, with gasket guides, type 304 stainless steel screw clamp, and matching neoprene (ASTM C-564) gasket that shall interlock with housing.

C. Joints in copper piping shall be made with tin-antimony solder (95-5) silver solder and non-acid flux.

D. Joints in threaded piping shall be made with teflon tape or non hardening pipe compound (Seal-tite).

2.5 VENT FLASHING

A. Furnish 4 lb. lead flashing, material as recommended by roofing system manufacturer, or copper pitch pans for all vents through the roof. Type of flashing used shall be compatible with piping material.

2.6 IDENTIFICATION

A. Below grade piping identification and warning tape shall be 0.004 inch thick polyethylene, printed with a continuous two line message. Tapes used for non magnetic piping materials

shall have a metallic core. Acceptable manufacturer is Seton Name Plate Corporation or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. The design drawings are generally diagrammatic. They do not show every bend, off-set, elbow or other fitting which may be required in the piping for installation in the space allotted. Careful coordination of the work is necessary to avoid conflicts.

B. PVC piping, fittings and other PVC materials shall not be installed in air conditioning plenums or equipment rooms used as air conditioning plenums.

C. Joints and connections shall be made permanent and watertight.

D. Run piping to sewer connection point outside of building or as indicated on drawings.

E. Install 3" and larger horizontal soil and waste piping to 1/8" per foot slope. Piping 2" and smaller shall be installed at a slope of 1/4" per foot. Run horizontal vent lines to a minimum grade back to stacks and vertical vent lines as direct and free from bends as possible.

F. For piping requiring insulation, lay out and carefully install piping with sufficient clearances to permit proper application of the insulation. If the piping is such that a neat insulation job cannot be obtained with reasonable effort, the piping subcontractor shall relocate piping.

G. Separate underground water piping and building sewer with undisturbed or compacted earth at least 10' horizontally if installed at the same level or lower than the sewer. Where water piping is closer than 10' to a sewer, place the bottom of the water pipe at least 18" above the top of the sewer, or the sewer shall be encased in a concrete envelope as required by the Department of Health & Rehabilitative Services (State of Florida).

H. Minimum cover for exterior underground piping is three feet over conduit unless otherwise noted on plans. Carefully excavate trench to smooth finished surface; if cut is too deep, backfill with clean earth and hand tamp to compact bottom. Make depression at joints to receive bells, collars, and couplings. Provide continuous support for pipe or conduit. Backfill to be clean earth, free of rocks and debris completely enveloping pipe or conduit on both sides and top to a minimum thickness of 6". Carefully hand tamp backfill in 6" layers until 18" has been deposited over pipe or conduit.

I. Place color coded 6" wide 0.004" thickness polyethylene printed plastic identification tape directly above all underground piping systems approximately 12" below finished grade. Tapes shall be continuously printed with "CAUTION" in large bold letters. Printed second line with type of service below. Red tape is to be used for sewer, (Print type of water on tape; i.e., storm water.)

3.2 HANGERS AND SUPPORTS

A. Vertical Piping shall be supported at its base and no greater than every story height, not to exceed 20 foot intervals.

B. Horizontal Piping (Suspended) shall be supported at each bend; at not more than five (5) foot intervals; except that pipe exceeding five (5) feet in length may be supported at not more than

ten (10) foot intervals. Supports shall be adequate to maintain alignment and prevent sagging and shall be made directly behind the bell or coupling, where possible, not near the center of the pipe.

C. Supports shall be connected to the building structure not from other equipment, ducts or conduits.

D. Horizontal pipe and fittings six inches and larger shall be suitably braced to prevent horizontal movement. This should be done at every branch opening or change of direction by the use of braces, blocks, rodding or other suitable method, to prevent movement.

E. Where components are suspended in excess of eighteen inches by means of non-rigid hangers, they should be suitably braced against movement horizontally, often called sway bracing.

3.3 LINE AND GRADE

A. Install gravity lines at uniform grade to low point after field verification of low point invert.

B. Run piping straight, plumb and grade in the direction indicated on the drawings.

3.4 JOINTING PIPE

A. All pipe lines shall be correctly aligned before joints are made.

B. Squarely cut pipe and properly ream to remove all constriction and burrs before making up the joints.

C. Threaded Pipe: Ream all pipe after cutting and before threading. Use non-hardening pipe compound on male threads only at each joint and tighten joint to leave not more than 3 threads exposed.

D. Copper Tube: Ream all pipe after cutting squarely, clean outside of tube ends and inside of fittings and tin end to be soldered. Apply non-acid solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.

E. Joining "NO-HUB" cast iron soil pipe and fittings shall be in accordance with recommended practices described by the coupling manufacturers.

F. Provide nipples of same material and weight as pipe used. Provide extra strong nipples when length of unthreaded part of standard weight nipple is less than 1-1/2".

G. Provide reducing fittings (reducing bushings shall not be used) where changes in pipe sizes occur.

H. Provide dielectric unions or flanges between copper and steel piping and between brassware and steel. Do not use steel and copper piping in the same system without such isolation.

3.5 PIPE PROTECTION

A. Paint all un-insulated piping underground (except cast iron) with two coats of asphaltic paint (Manual wiping is not acceptable).

B. Wrap soil pipe that touches metal or is exposed to masonry with a layer of 6 mil polyethylene film or 15 lb. roofing felt.

C. Spirally wrap all pipe lines embedded in concrete with two layers of 30 lb. roofing felt.

3.6 TESTS

A. A water test shall be applied to the sanitary and storm drainage systems either in its entirety or in sections. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening and the system filled with water to point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest openings of the section under test, and each section shall be filled with water, but no section shall be tested with less than 10 ft. head of water. In testing successive sections at least the upper 10 ft of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost 10 ft of the system) shall have been submitted to a test of less than a 10 ft head of water. The water shall be kept in the system, or in the portion under test, for at least 30 minutes before inspection starts; the system shall then be tight at all points.

B. An air test shall be made by attaching an air compressor or testing apparatus to any suitable opening and after closing all other inlets and outlets to the system, forcing air into the system until there is a uniform gauge pressure of 5 psi or sufficient to balance a column of mercury ten inches in height. This pressure shall be held without introduction of additional air for a period of at least 30 minutes.

C. Complete all field testing prior to insulation, wrapping and/or backfill.

3.7 VENT FLASHING

A. Extend lead type flashing 12" beyond pipe in all directions and carry to top of pipe with at least 2" return inside of pipe.

B. Install flashing materials as required by roofing system manufacturer's details and methods.

END OF SECTION 22 13 16

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 22 13 17
CLEANOUTS AND CLEANOUT ACCESS COVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division-01 Specification sections, apply to work of this section.

B. Alternates may be or may not substantially change scope and general character of the work; and must not be confused with "change orders", "substitutions", and other similar provisions.

1.2 SCOPE

A. Furnish and install cleanouts as shown on drawing or specified herein.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.4 SUBMITTALS

A. Submit manufacturer's data for review before any work is commenced.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleanouts and cleanout access covers shall be of the type and materials as scheduled on the drawings.

B. Provide all necessary bolts and appurtenances to effect a complete installation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all cleanouts and cleanout access covers in accordance with the manufacturer’s instructions.

B. Exterior cleanouts below grade shall be extended to finish grade. Pour a concrete pad 12" x 12" x 6" thick around cleanout; slope top down approximately 2" from cleanout to edge of pad so that edge of pad is flush with grade.

C. Cleanouts shall be of the same nominal size as the pipes to which they are connected up to 4" in diameter; and not less than 4" for larger pipes.

D. Cleanouts shall be provided at not more than 50 feet apart in horizontal drainage lines of 4" nominal diameter, and at not more than 75 feet apart for larger diameter pipe.

E. At change in direction: Cleanouts shall be provided at each change of direction of the building drain when the angle of change is 90 degrees.

F. At base of stacks: Cleanouts shall be provided at or near the base of each vertical stack and waste piping turning below ground.

G. Direction of cleanout: All cleanouts shall be installed so that the cleanout opens in a direction opposite to the flow of the drainage line, or at a right angle to the line.

H. Concealed cleanouts in wall shall be provided with removable access panel.

I. Cleanouts shall not be installed above ceilings (accessible or inaccessible ceilings). On buildings with multiple floors the cleanouts shall be installed as floor cleanouts on each level.

J. Where access cleanout boxes or covers are installed in the floor, the top surface shall be scoriated and the cover secured, but removable when necessary. Polished brass. Install carpet type covers in carpeted areas.

END OF SECTION 22 13 17

SECTION 22 13 19
FLOOR DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Furnish and install floor drains, floor sinks, trench drains including strainers and trap primers where indicated.

B. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders", "substitutions", and other similar provisions.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.4 SUBMITTALS

A. Submit manufacturer's data for review before any work is commenced.

PART 2 - PRODUCTS

2.1 DRAINS

A. Drains shall be of the type and materials as scheduled on the drawings.

B. Provide all necessary bolts, clamping rings and appurtenances to effect a complete installation.

C. The strainer size shall be as listed herein unless otherwise indicated larger on the drawings. The strainers shall be nickel alloy finish in exposed areas and polished brass in mechanical rooms. Provide tapped boss and trap primer floor drains as indicated on the drawings.

D. Floor drains in mechanical equipment rooms shall include heavy duty strainers and sediment bucket with a minimum 8-inch diameter strainer.

E. Floor drains in toilet rooms, showers and all areas receiving floor tile shall include minimum 7” x 7” square, nickel-plated strainers with heel-proof grating.

F. Floor Sinks: All floor sinks shall be cast-iron and include, at a minimum, an acid-resistant porcelain coating including the dome strainer located in the floor sink. All floor sinks shall include stainless steel frames with heavy-duty stainless steel grates. Where floor sinks receive indirect waste from kitchen equipment, sinks, etc. provide the required partial grating to allow the indirect waste to spill into the floor sink without waste from splashing onto the adjacent floor surfaces. Provide tapped boss and trap primer floor drains as indicated on the drawings.

G. Open Site/Hub Drains: Floor drains receiving air conditioning condensate and piped to the storm system shall be installed with the rim of the drain installed 1 inch above the finished floor slab and provide with a funnel accessory to accept the AC drain piping. Provide accessory backwater valve in each hub drain.

2.2 TRAP PRIMERS

A. Provide for all floor drains.

B. Units shall be cast bronze, with removable top cover, threaded or sweat pattern, and integral vacuum breaker.

C. Electronic Trap Primers: Provide electronic trap primers as scheduled to serve the quantity of floor drains/floor sinks indicated. Trap primer shall be in an enclosed primed/painted metal box with hinged door. Manifold shall include the required run-outs to serve the system drains.

D. Mechanical Trap Primers: provide where required for areas where electronic trap primers are not scheduled.

E. Acceptable manufacturers are: Sioux Chief, Wade, Josam, Smith and Zurn.

PART 3 - EXECUTION

3.1 DRAINS

A. Install all drains in accordance with the manufacturer’s instructions.

3.2 TRAP PRIMERS

A. Trap primer outlet should extend vertically a minimum of 12" before a change in direction to horizontal is made. The horizontal line to the trap primer connection shall be installed sloping to the trap it serves. Provide a minimum size of 12" x 12" stainless steel access cover for each trap primer.

END OF SECTION 22 13 19

SECTION 22 13 20
TRENCH DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Furnish and install area and trench drains including strainers.

B. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders", "substitutions", and other similar provisions.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.4 SUBMITTALS

A. Submit manufacturer's data for review before any work is commenced.

PART 2 - PRODUCTS

2.1 TRENCH DRAINS

A. Trench drains are scheduled on the drawings and shall be included with accessories as indicated.

B. Provide precast, concrete polymer, 12-inch wide extra heavy duty pre-sloped (0.6%) trench drain system. Trench drain grates shall be coated ductile iron with high strength securing bolts. Provide drainage end cap for side outlet piping connections sized per the drawings.

C. Acceptable manufacturer: *Basis of Design: JR Smith Model # 9828*. Manufacturer’s meeting this product specification shall be submitted for approval prior to bid as an “Or Equal” product.

PART 3 - EXECUTION

3.1 DRAINS

A. Install all drains in accordance with the manufacturer’s instructions.

END OF SECTION 22 13 20

SECTION 22 14 13
STORM AND CONDENSATE DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Storm drainage piping from exterior trench drains to the civil point of connection.
4. Condensate drainage piping from interior hub drains receiving air conditioning condensate to the exterior drywells.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm and Condensate Drainage Piping: 10-foot head of water (30 kPa).

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: Product data for roof drainage system pipe, fittings, etc.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For storm and condensate drainage piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 PVC PIPE AND FITTINGS

A. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.

1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Solvent Cement: ASTM D 2564.

1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Contractor shall be responsible for the providing the interconnection of the downspout piping indicated on the architectural drawings and the fabrication of the aluminum transitional boot to the downspout and the PVC piping storm connection to the point of connection required to the

Civil Utility connection on site. Provide a cleanout directly underground within two feet of the downspout.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for storm and condensate drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building storm and condensate drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install storm and condensate drainage piping at the following minimum slopes unless otherwise indicated:

1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

M. Install underground PVC piping according to ASTM D 2321.

N. Plumbing Specialties:

1. Install backwater valves, where indicated, in storm drainage gravity-flow piping.
2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping.
3. Install drains, where indicated, in storm drainage gravity-flow piping.

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

P. Install sleeves for piping penetrations of walls.

Q. Install sleeve seals for piping penetrations of concrete walls and slabs.

R. Install escutcheons for piping penetrations of walls.

3.2 JOINT CONSTRUCTION

A. Plastic, Non-pressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.3 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: non-pressure transition couplings.
3. Downspout-to-PVC Piping Boots: Provide a fabricated sheetmetal transitional boot fitting to transition from the gutter downspout to the under PVC storm drainage piping. Sheetmetal shall be field measured based upon the downspout size and specifically custom fabricated from rectangular to round. Transition finish shall match the downspout in material, gage and finish.

3.4 HANGER AND SUPPORT INSTALLATION

A. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

D. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3 (DN 80): 60 inches with 1/2-inch rod.
2. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches with 5/8-inch rod.
3. NPS 6 and NPS 8 (DN 150 and DN 200): 60 inches with 3/4-inch rod.
4. NPS 10 and NPS 12 (DN 250 and DN 300): 60 inches with 7/8-inch rod.
5. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

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

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

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches with 3/8-inch rod.
2. NPS 3 (DN 80): 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8 (DN 150 and DN 200): 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12 (DN 250 and DN 300): 48 inches with 7/8-inch rod.

G. Install supports for vertical PVC piping every 48 inches.

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect condensate drainage piping to interior hub drains and continue to the exterior connection of the drywell. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to fixtures and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.6 IDENTIFICATION

A. Provide metallic identification tape for all interior and exterior undergound storm and condensate drainage piping.

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm and condensate drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.8 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Piping NPS 6 (DN 150) and smaller shall be any of the following:

1. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Unshielded non-pressure transition couplings.

C. Piping, NPS 8 (DN 200) and larger shall be the following:

1. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Unshielded non-pressure transition couplings.

END OF SECTION 22 14 13

SECTION 22 15 13
COMPRESSED AIR EQUIPMENT, PIPING 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 SUMMARY

A. This Section includes piping and related specialties for general-service compressed-air systems operating at 200 psig and less. In addition, provide all required compressed air piping materials and accessories per the bus lift manufacturer's requirements for the associated bus lift system equipment.

1.3 DEFINITIONS

A. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 125 psig and less.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Pipes, tubes and fittings.
2. Flexible pipe connectors.
3. Safety valves.
4. Pressure regulators.
5. Filters.
6. Quick couplings.
7. Oil-Free Air compressor.
8. Integral Refrigerated Air Dryer.

B. Coordination Shop Drawings: For general-service compressed-air systems. Include relationship to other services that serve same work area. The compressed air piping system shop drawings shall indicate all of the associated distribution systems including the bus lift equipment, tire changers, air outlets, etc.

C. Brazing Certificates: As required by ASME Boiler and Pressure Vessel Code, Section IX, or AWS B2.2.

D. Welding Certificates: As required by ASME Boiler and Pressure Vessel Code, Section IX.

E. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

C. Comply with ASME B31.1, "Power Piping," for high-pressure compressed-air piping.

D. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
2. Basis of Design: Quincy Oil-Free scroll compressor, Model QOF.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PIPES, TUBES, AND FITTINGS

A. Copper Tube: ASTM B 88, Type K, seamless, drawn-temper, water tube.

1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
3. Copper Unions: ASME B16.22 or MSS SP-123.

B. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

C. Flexible Pipe Connectors: Corrugated tubing with wire-braid covering.

1. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

a. Working-Pressure Rating: 200 psig minimum.
b. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.

2. Stainless-Steel-Hose/Steel Pipe Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

   a. Working-Pressure Rating: 200 psig minimum.
   b. End Connections NPS 2 and Smaller: Threaded steel pipe nipple.
   c. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

3. Stainless-Steel-Hose/Stainless-Steel Pipe Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

   a. Working-Pressure Rating: 200 psig minimum.
   b. End Connections NPS 2 and Smaller: Threaded stainless-steel pipe nipple.
   c. End Connections NPS 2-1/2 and Larger: Flanged stainless-steel nipple.

2.4 JOINING MATERIALS

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for joining materials not in this Section.

2.5 VALVES

A. General-Duty Valves: Refer to Division 23 Section "Valves" for metal ball, butterfly, check, gate, and globe general-duty valves.

2.6 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet safety valve for compressed-air service.

   1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Combination Air-Line Pressure Regulator/Filter: Direct direct-acting, spring-loaded manual pressure-setting adjustment (0-125 psig), and rated for 200-psig minimum inlet pressure, unless otherwise indicated.

   1. Model: Cole-Parmer; Model R-79160-40 (13 CFM) for all compressed air drops.
   2. Filter: Polypropylene.

C. Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.

   1. Valveless Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.

      a. Socket End: With O-ring or gasket seal, without valve, and with serrated inlet for attaching hose.
      b. Plug End: With serrated outlet for attaching hose.

2.7 AIR COMPRESSOR (MAIN FIRE STATION)

A. Duplex, reciprocating air compressor shall be a package unit complete with, but not limited to, horizontal receiver, refrigerated air dryer, pressure gage, safety relief valve, ASME stamped horizontal receiver, electronic auto tank drain at base of receiver, check valve, after-cooler, inlet filter, inlet silencer, NEMA 3R control cabinet, motors coupling. Tank capacity as scheduled on the drawings.

B. Controls cabinet (NEMA-3R) shall contain adjustable pressure switches, fusible disconnect switches, 120 Volt control circuit transformer, across-the-line magnetic motor starters, automatic alternator for reversing the sequences of operation of compressor units, overload relays and reset switches on all three phases, hand-off-automatic selector switches in cabinet cover, green running lights, amber bypass lights and blue lead indicating lights mounted in cabinet cover with safety disconnect door.

C. Acceptable manufacturers are Quincy Model QR25-FF310 (Basis of Design) or approved equal (10 days prior to bid).

D. Refrigerated Air Dryer; Quincy Model # QRHT25 @ 120/1/60.

E. Air Filter: Provide Quincy Model CPN filter with isolation valves on the inlet/outlet piping. Filter at 0.01Micron; 0.01 PPM; Pre-Filter CSNT20; After-Filter CPNT20.

2.8 AIR COMPRESSOR (LOGISTICS BUILDING)

A. Duplex, reciprocating air compressor shall be a package unit complete with, but not limited to, horizontal receiver, refrigerated air dryer, pressure gage, safety relief valve, ASME stamped horizontal receiver, electronic auto tank drain at base of receiver, check valve, after-cooler, inlet filter, inlet silencer, NEMA 3R control cabinet, motors coupling. Tank capacity as scheduled on the drawings.

B. Controls cabinet (NEMA-3R) shall contain adjustable pressure switches, fusible disconnect switches, 120 Volt control circuit transformer, across-the-line magnetic motor starters, automatic alternator for reversing the sequences of operation of compressor units, overload relays and reset switches on all three phases, hand-off-automatic selector switches in cabinet cover, green running lights, amber bypass lights and blue lead indicating lights mounted in cabinet cover with safety disconnect door.

C. Acceptable manufacturers are Quincy Model QR25-FF310 (Basis of Design) or approved equal (10 days prior to bid).

D. Refrigerated Air Dryer; Quincy Model # QRHT25 @ 120/1/60.

E. Air Filter: Provide Quincy Model CPN filter with isolation valves on the inlet/outlet piping. Filter at 0.01Micron; 0.01 PPM; Pre-Filter CSNT20; After-Filter CPNT20.

2.9 AIR REELS

A. Grover Model Number 15500 (1/2”) Heavy-Duty Hose Reel Assembly with 75 feet hose and quick connect coupling.

2.10 IDENTIFICATION

A. Refer to Division 23 Section "Mechanical Identification for Piping, Ductwork and Equipment" for identification of piping, valves, gages, and specialties.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below, unless otherwise indicated.

B. Joining of Dissimilar Metal Piping: Use dielectric fittings. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for dielectric fitting types.

1. NPS 2 and Smaller: Dielectric unions.

C. Specialty and Equipment Flanged Connections: Use cast-copper-alloy companion flange with gasket and brazed joint for connection to copper tube.

D. Use of plastic piping for this application is prohibited.

E. Low-Pressure Compressed-Air Piping between Air Compressors and Receivers: Use the following piping materials for each size range:

1. NPS 2 and Smaller: Copper tube, wrought-copper fittings, and brazed joints.

F. Low-Pressure Compressed-Air Distribution Piping: Use the following piping materials for each size range:

1. NPS 2 and Smaller: Copper tube, wrought-copper fittings, and brazed joints.
2. Quincy AIRnet pre-painted air piping system complete with all fittings, isolation ball valves, pipe supports. Clamps, hangers, etc. is an option for the compressed air piping system serving the new bus lift system.

3.2 VALVE APPLICATIONS

A. General-Duty Valves: Refer to Division 23 Section "Valves" for metal general-duty valves. Use metal valves, unless otherwise indicated.

1. Metal General-Duty Valves: Use valve types specified in "Valve Applications" Article in Division 23 Section "Valves" according to the following:

a. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.

3.3 PIPING INSTALLATION

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping installation.

B. Install air and drain piping with 1 percent slope downward in direction of airflow.

C. Install eccentric reducers where piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

D. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

E. Install flexible pipe connector on each connection to air compressors.

3.4 VALVE INSTALLATION

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping and valve installation.

B. Install metal general-duty valves according to Division 22 Section "Valves."

C. Install shutoff valve at each connection to and from general-service compressed-air specialties, equipment, and accessories. Install strainer if indicated.

D. Install check valves to maintain correct direction of fluid flow to and from compressed-air piping specialties and equipment.

E. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

F. Install ball-type, isolation valve at hose reel and serv ice air drop outlet.

G. Install safety valves where recommended by specialty manufacturers.

H. Combination Air-Line Pressure Regulator/Filter: Provide a filter/regulator at each piece of air-operated equipment or hose reel and at each service air outlet prior to the quick-connect coupling.

3.5 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Pressure-Seal Joints: Select correct type of O-ring seals. Make joints with fitting manufacturer's tools and according to fitting manufacturer's written instructions.

C. Grooved Joints: Select correct type of gasket. Assemble joints with keyed-coupling housing, gasket, lubricant, and bolts according to coupling manufacturer's written instructions. Do not apply lubricant to pre-lubricated gaskets.

D. Join copper tubing with brazed joints. Use silver-composition or copper-phosphorus-composition filler metal and comply with CDA's "Copper Tube Handbook," Section VII, "Brazed Joints."

E. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.6 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 23 Section "Mechanical Vibration and Seismic Controls" for seismic-restraint devices.

B. Refer to Division 23 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 23 Section "Hangers and Supports."

D. Support horizontal piping within 12 inches of each fitting and coupling.

E. Support vertical piping and tubing at base and at each floor.

F. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/2: 72 inches with 3/8-inch rod.
2. NPS 3/4: 84 inches with 3/8-inch rod.
3. NPS 1: 96 inches with 3/8-inch rod.

H. Install supports for vertical copper tubing every 10 feet.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to specialties and equipment to allow service and maintenance.

C. Connect piping to air compressors, accessories, and specialties with shutoff valve and union or flanged connection.

D. Provide compressed air drops with isolation valve, regulator filter, quick connect fittings and blow-off valve per the detail on the drawings.

3.8 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping systems. Refer to Division 23 Section "Mechanical Identification" for labeling and identification materials.

3.9 EQUIPMENT INSTALLATION

A. Install all equipment in accordance with the manufacturer's requirements. Install compressor on a 6-inch high concrete pad and anchor the equipment to the pad.

3.10 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Test and adjust piping safety controls. Replace damaged and malfunctioning safety controls.
2. Piping Leak Tests: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

    a. Repair leaks and retest until no leaks exist.

3. Report results in writing.

END OF SECTION 22 15 13

SECTION 22 16 16
FACILITY LIQUEFIED-PETROLEUM GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Plumbing Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. For Piping Containing Only Vapor:

a. Piping and Valves: 125 psig unless otherwise indicated.

2. For Piping Containing Liquid:

a. Piping between Shutoff Valves: 350 psig unless otherwise indicated.
b. Piping Other Than Above: 250 psig unless otherwise indicated.
c. Valves and Fittings: 250 psig unless otherwise indicated.

3. Minimum Operating Pressure of Service Meter: 2 psig.

B. LPG System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig and is reduced to secondary pressure of 0.5 psig or less.

1.5 SUBMITTALS

A. Submit manufacturer's data for review before any work is commenced.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing LPG piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedules 40 and 80, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Not permitted underground.

d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground, and stainless steel underground.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

6. Mechanical Couplings:

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

1) GE Oil & Gas.
2) Smith-Blair, Inc.

b. Steel flanges and tube with epoxy finish.
c. Buna-nitrile seals.
d. Steel bolts, washers, and nuts.
e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

2.2 PIPING SPECIALTIES

A. Flexible Piping Joints:

1. Approved for LPG service.
2. Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
3. Minimum working pressure of 250 psig and 250 deg F operating temperature.
4. Flanged- or threaded-end connections to match equipment connected and shall be capable of minimum 3/4-inch misalignment.
5. Maximum 36-inch length for liquid LPG lines.

B. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches.

C. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.

5. Adjustable, retractable restraining cable.

D. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40 mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

E. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

F. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40 mesh startup strainer and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

G. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for LPG.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M.

2.4 MANUAL GAS SHUTOFF VALVES

A. Metallic Valves, NPS 2 and Smaller for Liquid Service: Comply with ASME B16.33 and UL 842.

1. CWP Rating: 250 psig
2. Threaded Ends: Comply with ASME B1.20.1.
3. Socket ends for brazed joints.
4. Listing by CSA or agency acceptable to authorities having jurisdiction for valves 1 inch and smaller.

5. Valves 1-1/4 inch and larger shall be suitable for LPG service, with "WOG" indicated on valve body.

B. General Requirements for Metallic Valves, NPS 2 and Smaller for Vapor Service: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
5. Service Mark: Valves 1-1/4 inch to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

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

    a. A.Y. McDonald Mfg. Co.
    b. Apollo Flow Controls; Conbraco Industries, Inc.
    c. BrassCraft Manufacturing Co.; a Masco company.
    d. Lyall, R. W. & Company, Inc.
    e. Perfection Corporation.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. CWP Rating: 600 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for LPG service with "WOG" indicated on valve body.

E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

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

    a. A.Y. McDonald Mfg. Co.
    b. Apollo Flow Controls; Conbraco Industries, Inc.
    c. BrassCraft Manufacturing Co.; a Masco company.
    d. Lyall, R. W. & Company, Inc.
    e. Perfection Corporation.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.

5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. CWP Rating: 600 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for LPG service with "WOG" indicated on valve body.

F. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.

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

    a. A.Y. McDonald Mfg. Co.
    b. Apollo Flow Controls; Conbraco Industries, Inc.
    c. BrassCraft Manufacturing Co.; a Masco company.
    d. Lyall, R. W. & Company, Inc.
    e. Perfection Corporation.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. CWP Rating: 600 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for LPG service with "WOG" indicated on valve body.

G. Bronze Plug Valves: MSS SP-78.

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

    a. A.Y. McDonald Mfg. Co.
    b. Lee Brass Company.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Operator: Square head or lug type with tamperproof feature where indicated.
5. Pressure Class: 125 psig.
6. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
7. Service: Suitable for LPG service with "WOG" indicated on valve body.

H. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

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

    a. A.Y. McDonald Mfg. Co.
    b. Mueller Co.
    c. Xomox Corporation.

2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.

4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with LPG.
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for LPG service with "WOG" indicated on valve body.

I. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

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

    a. A.Y. McDonald Mfg. Co.
    b. Flowserve Corporation.
    c. Homestead Valve.
    d. Milliken Valve Company.
    e. Mueller Co.
    f. R & M Energy Systems; Robbins & Myers.

2. Body: Cast iron, complying with ASTM A 126 Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with LPG.
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for LPG service with "WOG" indicated on valve body.

J. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head and with stem of length required to operate valve.

2.5 MOTORIZED GAS VALVES

A. Hydrostatic Relief Valves: Comply with NFPA 58.

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

    a. Engineered Controls International, Inc.
    b. Fisher Control Valves & Instruments; a brand of Emerson Process Management.
    c. Murray Equipment, Inc.
    d. Sherwood.

2. Operating Pressure: 350 psig.
3. Body: Brass.
4. Spring: Stainless steel.

5. Disc and Seat: Nitrile.
6. Brass body and stainless-steel, spring-operated valve with resilient rubber disc seat and protective cap.
7. Factory set and tested.
8. Listing: Valves listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Valve shall reseat after relieving pressure.

B. Automatic Gas Valves: Comply with ANSI Z21.21.

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

   a. ASCO Valve Canada; a division of Emerson Electric Canada Limited.
   b. Dungs, Karl, Inc.
   c. Eaton.
   d. Eclipse Innovative Thermal Technologies.
   e. Honeywell Building Solutions; Honeywell International, Inc.
   f. Johnson Controls.

2. Body: Brass or aluminum.
3. Seats and Disc: Nitrile rubber.
4. Springs and Valve Trim: Stainless steel.
5. Normally closed.
6. Visual position indicator.
7. operator for actuation by appliance automatic shutoff device.

C. Electrically Operated Valves: Comply with UL 429.

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

   a. ASCO Valve Canada; a division of Emerson Electric Canada Limited.
   b. Dungs, Karl, Inc.
   c. Eclipse Innovative Thermal Technologies.
   d. Goyen Valve Corp.
   e. Magnatrol Valve Corporation.
   f. Parker Hannifin Corporation.
   g. WATTS.

2. Pilot operated.
3. Body: Brass or aluminum.
4. Seats and Disc: Nitrile rubber.
5. Springs and Valve Trim: Stainless steel.
6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.
8. Normally closed.
9. Visual position indicator.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for LPG.

2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

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

    a. Actaris.
    b. American Meter Company.
    c. Fisher Control Valves & Instruments; a brand of Emerson Process Management.
    d. Invensys.
    e. Itron Gas.
    f. Richards Industries.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

C. Line Pressure Regulators: Comply with ANSI Z21.80.

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

    a. Actaris.
    b. American Meter Company.
    c. Eclipse Innovative Thermal Technologies.
    d. Fisher Control Valves & Instruments; a brand of Emerson Process Management.
    e. Invensys.
    f. Itron Gas.
    g. Maxitrol Company.
    h. Richards Industries.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure sensing piping external to the regulator.

9. Pressure regulator shall maintain discharge pressure setting downstream and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.

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

a. Canadian Meter Company Inc.
b. Eaton.
c. Harper Wyman Co.
d. Maxitrol Company.
e. SCP, Inc.

2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

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

a. A.Y. McDonald Mfg. Co.
b. Capitol Manufacturing Company.
c. Central Plastics Company.
d. HART Industrial Unions, LLC.
e. Jomar Valve.
f. Matco-Norca.
g. WATTS.
h. Wilkins.

2. Description:

a. Standard: ASSE 1079.
b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

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

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Matco-Norca.
d. WATTS.
e. Wilkins.

2. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

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

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Gasket: Neoprene or phenolic.
c. Bolt Sleeves: Phenolic or polyethylene.
d. Washers: Phenolic with steel backing washers.

2.8 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for LPG piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Close equipment shutoff valves before turning off LPG to premises or piping section.

B. Inspect LPG piping according to NFPA 58 and the International Fuel Gas Code to determine that LPG utilization devices are turned off in piping section affected.

C. Comply with NFPA 58 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 58 and the International Fuel Gas Code requirements for installation and purging of LPG piping.

B. Install underground, LPG piping buried at least 36 inches below finished grade.

1. If LPG piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground LPG piping according to ASTM D 2774.

D. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

E. Install fittings for changes in direction and branch connections.

F. Joints for connection to inlets and outlets on vaporizers, air mixers, regulators, and valves may be flanged or threaded to match the equipment.

G. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

3.4 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of LPG piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install LPG piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where readily accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Concealed Location Installations: Except as specified below, install concealed LPG piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: LPG piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install LPG piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install LPG piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

    a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:

    a. Do not install LPG piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install LPG piping in solid walls or partitions.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

T. Do not use LPG piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

W. Install sleeves for piping penetrations of walls, ceilings, and floors.

X. Install sleeve seals for piping penetrations of concrete walls and slabs.

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.5 SERVICE-METER ASSEMBLY INSTALLATION

A. Install service-meter assemblies aboveground, on concrete bases.

B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.

C. Install strainer on inlet of service-pressure regulator and meter set.

D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.

F. Install service meters downstream from pressure regulators.

G. Install metal bollards to protect meter assemblies.

3.6 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.7 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full ID of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Ch. 22, "Pipe and Tube."

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for LPG service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

3.8 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping.

B. Comply with requirements for pipe hangers and supports specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

D. Install hangers for horizontal, drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2 and NPS 5/8: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and NPS 7/8: Maximum span, 84 inches; minimum rod size, 3/8 inch.
4. NPS 1: Maximum span, 96 inches; minimum rod size, 3/8 inch.

E. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod, 3/8 inch.

3.9 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install LPG piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliances and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

A. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 PAINTING

A. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.

B. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

a. Prime Coat: metal primer.
b. Intermediate Coat: Interior latex matching topcoat.

2. Alkyd System: MPI INT 5.1E.

a. Prime Coat: metal primer.
b. Intermediate Coat: Interior alkyd matching topcoat.

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge LPG according to NFPA 58 and the International Fuel Gas Code and requirements of authorities having jurisdiction.

C. LPG piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.13 OUTDOOR PIPING SCHEDULE

A. Underground LPG liquid piping shall be the following:

1. Schedule 40 steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground LPG liquid piping shall be one of the following:

1. NPS 2 and Smaller: Schedule 40 steel pipe, malleable-iron threaded fittings and threaded and seal welded joints. Coat pipe and fittings with protective coating for steel piping.
2. NPS 2-1/2 and Larger: Schedule 40, steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.

C. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper, with wrought-copper fittings and joints. Install piping embedded in concrete with no joints in concrete.

D. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be[one of the following:

1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
2. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.

C. Underground, below building, piping shall be one of the following:

1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.

D. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Schedule 40, steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be the following:

1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
2. Schedule 40, steel pipe with steel welding fittings and welded joints.

C. Underground, below building, piping shall be one of the following:

1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.

D. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Schedule 40, steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.16 ABOVE GROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Aboveground Liquid Piping:

1. Two-piece, bronze ball valves with bronze trim.

B. Valves for pipe NPS 2 and smaller at service meter shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, bronze ball valves with bronze trim.
3. Bronze plug valve.

C. Valves for pipe NPS 2-1/2 and larger at service meter shall be one of the following:

1. Two-piece, port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

D. Distribution piping valves for pipe NPS 2 and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, bronze ball valves with bronze trim.
3. Bronze plug valve.

E. Distribution piping valves for pipe NPS 2-1/2 and larger shall be one of the following:

1. Two-piece, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, plug valve.

F. Valves in branch piping for single appliance shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, bronze ball valves with bronze trim.
3. Bronze plug valve.

3.17 OTHER REQUIREMENTS

A. All gas piping shall be installed in strict accordance with the requirements of the local gas company and the American Gas Association rules and regulations.

END OF SECTION 221616

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 22 34 36
COMMERCIAL, TANKLESS CONDENSING GAS WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following for domestic water systems:

1. Commercial, tankless, condensing gas water heaters.
2. Compression tanks.
3. Accessories.

1.3 SUBMITTALS

A. Product Data: For each type and size of water heater. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

B. Shop Drawings: Detail water heater 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 systems. Differentiate between manufacturer-installed and field-installed wiring.

C. Product Certificates: Signed by manufacturers of water heaters certifying that products furnished comply with requirements.

D. Maintenance Data: For water heaters to include in maintenance manuals specified in Division 01.

E. Warranties: Warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on specific units indicated. Other manufacturers' products complying with requirements may be considered. Refer to Division 01 Section "Substitutions."

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

D. ANSI Compliance: Provide gas water heaters that comply with ANSI standards for gas water heaters and related products and that bear AGA certification label.

E. ASHRAE Standards: Comply with performance efficiencies prescribed for the following:

1. ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," for commercial water heaters.

1.5 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

1. Warranty Period: From date of Substantial Completion:

a. Parts: 5 year limited parts warranty.
b. Burner Assemblies: Five years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Commercial, Tankless, Condensing Gas Water Heaters:

a. Noritz corp.
b. Rinnai.
c. Intelli-Hot.

2.2 COMMERCIAL, TANKLESS, CONDENSING GAS WATER HEATERS

A. Description: ANSI Z21.10.3 and AGA certified; commercial, fully condensing tankless, water heater for natural or LP gas fuel as scheduled. Gas supply pressure range shall be 4.0”-10.5” for natural gas and 8.0”-14.0” for propane gas. Water heater shall have multi-system compatibility linking water heaters from a 2 unit quick-connect or multi-unit system controller for up to 24 units.

B. Construction: Stainless steel case, copper heat exchanger, stainless steel dual-flame burner, aluminum gas control valves and condensate collector.

1. Working-Pressure Rating: 150 psig (1035 kPa).
2. Tappings: ¾” brass inlet/outlet water connections.

3. Interior Finish: Materials complying with NSF 61, barrier materials for potable-water tank linings.
4. Casing: Stainless steel.

C. Dual Heat Exchanger: Manufactured with commercial grade copper.

1. Temperature Control: Adjustable thermostat range from 100-185 Deg F.
2. Safety Control: Flame Sensor, Over-Heat Protection Device, Lightning Protection Device, Thermal cut-off fuses, Fan rotator detector and Neutralizer Over-Fill.
3. Automatic Ignition: ANSI Z21.20, direct, automatic gas-ignition system and components.
4. Thermal Efficiency: fully condensing, 94% efficient for use with natural gas or propane.
5. Burner: direct-ignition, dual flame burner, fully modulating.

D. Direct-Vent System: Provide DOUBLE-WALL STAINLESS STEEL intake/exhaust concentric, vent assembly and fittings (as indicated) from the water heater connection up thru the roof with outside intake/exhaust screen.

2.3 COMPRESSION TANKS

A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tank.

B. Construction: 150-psig (1035-kPa) working-pressure rating.

C. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.

D. Tank Interior Finish: Materials and thicknesses complying with NSF 61, barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

E. Tank Exterior Finish: Manufacturer's standard, unless finish is indicated.

F. Air-Charging Valve: Factory installed.

2.4 WATER HEATER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: According to the following:

1. Isolator Valve Kit.
2. Option: Separate temperature and pressure relief valves are acceptable instead of combination relief valve.
3. Exception: Omit combination temperature and pressure relief valve for tankless water heater, and furnish pressure relief valve for installation in piping.

B. Gas Shutoff Valves: ANSI Z21.15, manually operated. Furnish for installation in piping.

C. Neutralization Kit: provide condensate neutralization kit for each water heater.

D. Gas Pressure Regulators: ANSI Z21.18, appliance type, factory or field installed. Include pressure rating, capacity, and pressure differential required for water heater and gas supply.

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

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. 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.

B. Anchor water heaters to substrate.

C. Install and connect gas water heaters according to NFPA 54.

1. Install appliance, gas pressure regulators on gas-burner inlets of water heaters without pressure regulators.
2. Install vent piping from gas-train pressure regulators and valves to outside of building where required. Terminate vent piping with brass-screened vent cap fitting. Do not combine vents except with approval of authorities having jurisdiction.

D. Install pressure relief valves in water piping for water heaters without storage. Extend relief valve outlet with water piping in continuous downward pitch and discharge onto closest floor drain.

E. Install vacuum relief valves in cold-water-inlet piping.

F. Install thermometers on water heater inlet and outlet piping.

1. Exception: Omit thermometers for the following:

a. Commercial, point-of-use, water heater inlet piping.

G. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve, and thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet.

H. Arrange for insulation on equipment and piping not furnished with factory-applied insulation.

I. Charge compression tanks with air.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect hot- and cold-water piping with shutoff valves and unions. Connect hot-water-circulating piping with shutoff valve, check valve, and union.

D. Connect gas piping to gas burner with drip leg, tee, shutoff valve, and union; minimum size same as inlet connection.

E. Make connections with dielectric fittings where piping is made of dissimilar metal.

F. Gas, Water Heater Vent Connections: Provide PVC intake and exhaust piping sized and installed per the manufacturer's recommendations and installation manual requirements. Terminate the vent piping in a sidewall or vertical roof penetration as indicated on the drawings. Provide birdscreens and weather-proof caps per the manufacturer's technical requirements.

G. Electrical Connections: Power wiring and disconnect switches are specified in Division 26 Sections. Arrange wiring to allow unit service.

H. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Engage a factory-authorized service representative to perform startup service.

B. In addition to manufacturer's written installation and startup checks, perform the following:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment and retest until satisfactory results are achieved.
2. Verify that piping system tests are complete.
3. Check for piping connection leaks.
4. Check for clear relief valve inlets, outlets, and drain piping.
5. Check operation of circulators.
6. Test operation of safety controls, relief valves, and devices.
7. Energize electric circuits.
8. Adjust operating controls.
9. Adjust hot-water-outlet temperature settings. Do not set above 120 deg F unless piping system application requires higher temperature.
10. Balance water flow through manifolds of multiple-unit installations.

3.4 DEMONSTRATION

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

1. Train Owner's maintenance personnel on procedures for starting and stopping troubleshooting, servicing, and maintaining equipment.
2. Review data in maintenance manuals. Refer to Division 01 Section "Contract Closeout."
3. Review date in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data."
4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 22 34 36

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 22 40 05
PLUMBING FIXTURES AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Furnish and install plumbing fixtures indicated on drawings or specified herein.

B. All plumbing fixtures shall be "First Quality" as defined and set forth in Commercial Standard CS77-28 as promulgated by the U.S. Department of Commerce. All fixtures are to be white vitreous china unless otherwise specifically noted. Where enameled iron fixtures are specified, they shall be furnished with acid resisting enamel.

C. Fixtures shall be properly protected from damage during construction and shall be cleaned in accordance with manufacturer's instruction under this section of the specifications.

D. Fixtures and fittings proposed shall be from one manufacturer and of similar character in any room or location. Escutcheons, handles, etc., on the different fixtures shall be of the same design.

E. The fixture numbers and types are scheduled on the drawings and are used to indicate type and quality of fixtures desired. Acceptable fixture manufacturers are as follows: American Standard, Sloan and Elkay. Fixture manufacturers not listed herein will be considered subject to the general requirement outlined in Section 23 01 00 General Mechanical Provisions.

F. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders", "substitutions", and other similar provisions.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.4 SUBMITTALS

A. Submit manufacturer's data for review before any work is commenced.

1.5 MANUFACTURERS

A. Equipment items listed in the schedule on the drawings are based on a specific manufacturer to establish the desired style, quality, performance, and type of equipment. Equal products,

complying with the required installation shown on the plans and with these specifications, by the following manufacturers (only) are acceptable.

B. Flush Valves and Wall-Mounted Fixtures (Water Closets and Urinals):

1. American Standard Fixtures; Floor-Mounted (Water Closets for ADA and Standard Height) with Sloan 1.28 GPF Battery-Operated/Sensored Flush Valve; American Standard Urinal with Sloan Battery-Operated/Sensored 0.125 GPF Flush Valve.

C. Lavatory Fixtures:

1. Vitrous China: American Standard with models as scheduled.
2. Stainless Steel: Elkay with Models as scheduled.

D. Sinks: Nickel bearing Stainless steel, 18-gage sinks with sound deadening. Mounting as scheduled.

1. Elkay: Models as scheduled.

E. Sink Faucets:

1. T & S Brass: Models as scheduled.

F. Mop Basins:

1. Fiat: Models as scheduled with mop hanger, stainless steel wall guards, hose assembly.
2. Stern Williams: Models as scheduled.

G. Electric Water Coolers: Models as scheduled.

H. Physical Water Conditioner (PWC): Aqua-Rex model as scheduled.

I. Grease Interceptor (GI): Highland Tank Model AGI-50 M with Control Panel and 115-volt power cord connected to a GFI Receptacle.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Water closet seats shall be elongated open-front commercial, heavy-duty, with self-sustaining stainless steel hinges.

B. All exposed metal not otherwise specified shall be polished chromium on brass or bronze. All supply valves shall have renewable seats and discs. All hot and cold water supply to fixtures shall be provided with stops. Provide P-trap with cleanout for each lavatory and sink except as specifically noted.

C. Chair carriers and combination chair carriers and fittings shall be as scheduled on the drawings.

D. Chrome-plated. Provide where exposed piping passes through finished surfaces. Escutcheons for extended sleeves shall be of the type designed for that purpose.

E. Provide a concealed hanger type lavatory chair carrier with short foot mounted in the chase to support lavatories shown on walls of a chase. Provide Zurn Model Z1224 or equal.

F. Provide a concealed hanger type urinal carrier with short foot mounted in the chase to support lavatories shown on walls of a chase. Provide Zurn Model Z1221 or equal.

G. Provide through toggle bolts, 1/8" thickness steel backing plate, and wall hangers for support of lavatories on 6" or thicker concrete block walls.

H. Provide ASSE approved tempering valve for all lavatory fixtures to maintain 105 deg F water supply maximum.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Layout fixtures as indicated on the drawings.

B. Carefully install fixtures in accordance with manufacturer's data with sufficient clearances to coordinate with accessories, specialties and equipment specified in other divisions of these specifications and/or as shown on the drawings.

C. Hangers and carriers shall be installed in accordance with manufacturer's recommendations and in accordance with good practice and workmanship.

D. Clean all exposed metal surfaces from grease, dirt, paint or other foreign material.

E. All sensored lavatory fixture faucets shall be roughed-in and located to avoid visibility of the battery-operated controller and tempering valve. Maintain accessibility for maintenance.

F. All exposed CW and HW supplies to fixtures shall be chrome-plated finish.

G. Fixtures shall be properly protected from damage during construction and shall be cleaned in accordance with manufacturer's instruction under this section of the specification.

H. Fixtures, chrome-plated piping, fittings and trim shall be polished before requesting acceptance of the system.

END OF SECTION 22 40 05

THIS PAGE INTENTIONALLY LEFT BLANK

Division 23

Heating, Ventilating and Air Conditioning

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 01 00
GENERAL MECHANICAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE OF DIVISION

A. Work shall include all materials, equipment and labor necessary for a complete and properly functioning mechanical installation in accordance with all applicable codes, and contract drawings and specifications. Work shall include all work specified in Division-22, Plumbing and Division-23, HVAC.

B. Pay for all required licenses, fees, inspections and permits.

C. *MANDATORY PRE-FABRICATION/INSTALLATION MEETING:* THE GENERAL CONTRACTOR SHALL INCLUDE ALL ASSOCIATED TRADES IN A MANDATORY PRE-FABRICATION AND PRE-INSTALLATION MEETING ON SITE. THE SHEETMETAL CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING COORDINATED SHOP DRAWINGS FOR FINAL COORDINATION WITH ALL OTHER TRADES.

1.3 RELATION TO OTHER WORK

A. Work Not in Divisions 22 and 23: Related work not included in this division consists of requirements given in the following as may be included in the contract documents:

1. Other divisions which may include work (such as concrete, steel, painting, ceiling systems, structure and other work) related to the work of Divisions 22 and 23.

B. Work of Divisions 22 and 23: Any or all sections of Divisions 22 and 23 may include a paragraph or paragraphs under the heading, "Relation to other Work". Where such a paragraph is indicated and work directly related to the section is listed or described, such work shall be considered as relating directly to the indicated section. Any related work (directly related or otherwise) which may be omitted by reference from the "Relation to Other Work" paragraph of such section(s), shall be provided as necessary and required whether or not such work is included by reference. Such listing or description of related work within a section is given only as a convenience to the Contractor; omission of other related sections or described work does not in any way exclude the provision of such work.

1.4 CODES

A. Install all work in accordance with the latest edition of all applicable regulations and governing codes, including the regulations of the utility companies serving the project.

B. Where a conflict in code requirements occurs the more stringent requirement shall govern.

1.5 STANDARDS

A. All equipment and devices shall bear U.L. label, the label of an industry recognized approved testing agency or A.G.A. certification for said item of equipment or device.

B. All electrical devices must be U.L. approved.

1.6 DRAWINGS

A. Architectural and structural drawings take precedence over mechanical drawings with reference to the building construction. Mechanical drawings are diagrammatic and indicate the general arrangement and extent of work. Architectural drawings indicate more exactly the desired relationship between diffusers, registers, lighting fixtures, equipment, electric panels and devices, plumbing fixtures, and other items which remain exposed in the completed building. Exact locations and arrangement of materials and equipment shall be determined, with the acceptance of the Architect/Engineer, as work progresses to conform in the best possible manner with the surroundings and with the adjoining work of other trades. Where locations of equipment, devices or fixtures are controlled by architectural features, establish such locations by referring to dimensions on Architectural drawings and not by scaling drawings.

1.7 DISCREPANCIES

A. In case of differences between drawings and specifications, or where drawings and specifications are not clear or definite, the subject shall be referred to Architect/Engineer for clarification and instructions.

1.8 ELECTRICAL PROVISIONS

A. Work of Divisions 22 and 23 shall include the electrical requirements which are indicated to be integral with mechanical work and which can be summarized to include (but not necessarily be limited to) the following:

1. Motors.
2. Motor starters.
3. Wiring from mechanical equipment to electrical work termination (junction box or disconnect switch).
4. Control switch, pilot lights, interlocks and similar devices.
5. Electrical heating coils and similar elements in mechanical equipment.
6. Electrical work specified in Division-23 for the HVAC control system.
7. Drip pans to protect electrical work.

B. Motors, Starters, Switches: Provide with all motorized mechanical equipment unless otherwise indicated.

C. Drip Pans: Where possible, do not run mechanical piping directly above electrical (or electronic) equipment which is sensitive to moisture; otherwise provide drip pans under mechanical piping. Locate pan below piping, and extend 6" on each side of piping and lengthwise 18" beyond equipment. Fabricate pans 2" deep, of reinforced sheet metal with rolled edges and soldered or welded seams; 20 gage copper, or 16 gage steel with 2 oz. zinc finish hot dipped after fabrication. Provide 3/4" copper drainage piping, properly discharged.

D. Motors: Unless specifically specified otherwise in the section covering the driven equipment (or the equipment drives), motors shall comply with the following:

1. Three Phase: NEMA design B, three-phase, squirrel cage induction type designed for 1800 rpm synchronous speed for operation in 40°C ambient at 1.15 service factor at constant speed on the scheduled voltage. Motors shall be insulated with Class B insulation material and shall be cast iron, drip proof, horizontal foot mounted type with ball bearings. Two speed motors shall be provided as scheduled and shall be two winding type.
2. Single Phase: Squirrel cage induction type designed for 1800 rpm synchronous speed for operation in 40°C ambient at 1.15 service factor at constant speed on the scheduled voltage. Motors shall be insulated with Class B insulation materials and shall be two winding capacitor start type with steel enclosure, drip proof, horizontal foot mount and ball bearings.
3. Electric motors which are designated to be high efficiency type shall also comply with the section describing high efficiency motors.

E. Scheduled Horsepower: The horsepowers scheduled or specified are those nominal sizes estimated to be required by the equipment when operating at specified duties and efficiencies. If the actual horsepower for the equipment furnished differs from that specified or shown on the drawings, it shall be the Contractor's responsibility to insure that proper size feeders, breakers, starters, etc. are provided at no change in contract price.

F. Any TEFC motors shall have Class F insulation.

G. Drip proof protected motors shall have Class B insulation.

H. Manufacturer: Electric motors, complying with the requirements of this Section and the installation and performance requirements of the plans, by the following manufacturers are acceptable:

1. Reliance Electric
2. Gould Electric
3. General Electric
4. Westinghouse

1.9 ELECTRICAL/MECHANICAL WORK

A. Definitions: Definitions for the purpose of mechanical/electrical control and power coordination are as follows: (Note: The use of the words, "Provide", "furnish" and "install" are intended only for use in describing the coordination indicated by this paragraph and do not necessarily have the same definitions when used outside of the context of this paragraph.) Any items which do not fall within the scope of this paragraph shall be coordinated as individually specified.

1. "Furnish" means to procure an item and to deliver it to the project for installation.
2. "Install" means to determine (in coordination with others as necessary) the appropriate intended location of an item and to set and connect it in place.
3. "Provide" means to both furnish and install.
4. Power Circuit: Circuit which carries main electric power to apparatus to which the power circuit is connected.
5. Control Circuit: Circuit which carries electrical signals directing the performance of a controller but which does not carry the main electric power. (See NEC, Section 430-71.) Such circuits shall also include those which serve a dual control and power function (e.g., a line voltage thermostat circuit which both activates and powers a small fan motor).

6. Controller: A device, or group of devices, which serves to govern, in some predetermined manner, electric power delivered to apparatus to which the controller is connected and includes any switch or device normally used to start and stop a motor. (See NEC, Article 100, Definitions, "Controller", and Section 430-81(a).)
7. Control Device: A device which reacts to an operating condition (pressure, temperature, flow, humidity, etc.) and which initiates transmission of an electrical control signal which causes operation of a controller or which causes operation of pressure switches, etc.
8. Auxiliary Control Device: A device (such as a low voltage control transformer, electric relay, etc.) which is located in a control circuit and which carries or responds to (but does not initiate) an electrical control signal initiated by a control device.

B. Work of Division-23 includes (but is not necessarily limited to):

1. Provide:

a. All controllers which are generally manufactured or shipped as integral with Division-23 equipment (such as starters packaged with air cooled chillers, etc.).
b. All electric motors and other electrical power consuming equipment (such as electric air heating coils, electric boilers, electric hot water heaters, etc.) which are specified in Division 22 or 23.
c. All control circuits (including conduit and boxes) from the Division-26 panels to point of use including the necessary circuit breakers.
d. All other control circuits, including conduit and boxes.
e. All control connections to equipment.
f. All control connections to controllers, switches, motors and other mechanical systems electrical power consuming equipment (such as electric air heating coils, electric boilers, electric hot water heaters, etc.).
g. Auxiliary control devices.
h. All control devices (thermostats, pressure switches, flow switches, humidistats, etc.) and make control circuit connections thereto.
i. Any and all electronic and electric control devices and electric connections thereto.

2. Furnish:

a. All controllers which are generally manufactured and/or shipped as separate but companion items to Division-23 equipment (such as centrifugal chiller starters which are matched with the chillers but are not physically an integral part of the chiller assembly.)

C. Work of Division-26 includes (but is not necessarily limited to):

1. Provide:

a. All power circuits, including conduit and boxes.
b. All power connections to controllers, switches, motors and other mechanical systems electrical power consuming equipment (such as electric air heating coils, electric boilers, electric hot water heaters, etc.).
c. All remote motor disconnects (remote from the related controller) at all locations required by NEC and connections thereto except those disconnects which are specified in Division-23 to be provided as part of the equipment itself.
d. All controllers (except those which are generally manufactured or shipped as separate but companion items to Division-23 equipment such as centrifugal chiller starters).

2. Install:

a. All controllers which are generally manufactured and/or shipped as separate but companion items to Division-23 equipment (e.g., chiller starters).

1.10 AUXILIARIES AND ACCESSORIES

A. Include all auxiliaries and accessories for complete and properly operating systems.

1.11 COORDINATION

A. Provide all required coordination and supervision where work of this division connects to or is affected by work of others.

1.12 PROVISIONS FOR OPENINGS

A. Provide all openings required for work performed under Division-23. Provide sleeves or other approved methods to allow passage of items installed under any Section of Division-23.

1.13 CLEANING AND PROTECTION

A. Ductwork: Keep the interior of the duct system free from dirt and rubbish and other foreign matter. All fan motors, switches, and other items, shall also be protected from dirt, rubbish and other foreign matter during building construction. Thoroughly clean all components of the ductwork and remove all dirt, scale, oil and other foreign substances which may have accumulated during the installation process.

B. Equipment: All mechanical equipment provided shall be thoroughly cleaned of all dirt, oil, concrete, etc. Any dents, scratches or other visible blemishes shall be corrected and the appearance of the equipment made "like new" and to the satisfaction of the Architect/Engineer.

C. Upon completion, and before final acceptance of the work, all debris, rubbish, leftover materials, tools and equipment shall be removed from the site.

D. Protection of Work Until Final Acceptance: Protect all materials and equipment from damage, entrance of dirt and construction debris from the time of installation until final acceptance. Any materials and equipment which are damaged shall be repaired to "as new" condition or replaced at the direction of the Architect/Engineer. Where factory finishes occur and damage is minor, finishes may be touched up. If, in the opinion of the Architect/Engineer the damage is excessive, factory finish shall be replaced to "new" condition.

1.14 SHOP DRAWINGS

A. Submit shop drawings electronically as PDF files for all items, services and systems included in the project.

B. Shop drawings shall clearly show the following:

1. Technical and descriptive data in detail equal to or greater than the data given in the item specification. Indicate all characteristics, special modifications and features. Where

performance and characteristic data is shown on the drawings or specified, submitted data shall be provided in a degree which is both quantitatively and qualitatively equal to that specified and shown so that comparison can be made. Present data in detail equal to or greater than that given in item specification and include all weights, deflections, speeds, velocities, pressure drops, operating temperatures, operating curves, temperature ranges, sound ratings, dimensions, sizes, manufacturers' names, model numbers, types of material used, operating pressures, full load amperages, starting amperages, fouling factors, capacities, set points, chemical compositions, certifications and endorsements, operating voltages, thicknesses, gauges and all other related information as applicable to particular item.

2. Exceptions to or deviations from the contract documents. Should Architect/Engineer accept any items having such deviations which are not clearly brought to Architect/Engineer's attention, in writing, on item submittal, then Contractor is responsible for correction of such deviations regardless of when such deviations are discovered.

C. Additional Requirements: See specific sections of the Specifications for any additional requirements.

1.15 SHOP DRAWINGS TECHNICAL INFORMATION BROCHURE

A. Submit electronically a PDF file of product data for each of the items under specific sections.

1.16 SHOP DRAWINGS FOR PIPING SYSTEMS AND DUCT SYSTEMS *(MANDATORY)*

A. The HVAC systems in this project are of a higher than normal complexity and will require the mechanical/sheetmetal contractor to produce shop drawings for piping systems and duct systems. All shop drawings shall be done in minimum ACAD 2013 format and shall be of sufficient scale to verify clearances and equipment locations. ACAD base files of the building will be provided to the contractor. Shop drawings shall show actual approved mechanical equipment dimensions and all maintenance and operational clearances required. Shop drawings shall also include sections through mechanical/electrical rooms and similar areas such showing levels of ductwork, sprinkler piping, lighting, electrical gear, etc. Title drawings shall include identification of project and names of Architect, Engineer, Contractor, subcontractor and/or supplier, date, be numbered sequentially and shall indicate the following:

1. Architectural and structural (as required) backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.

    a. Fabrication and Erection dimensions.
    b. Arrangements and sectional views.
    c. Necessary details, including complete information for making connections with other work.
    d. Kinds of materials and finishes.
    e. Descriptive names of equipment.
    f. Modifications and options to standard equipment required by the contract.
    g. Leave blank area, size approximately 4 by 2-1/2 inches, near title block (for Engineer's shop drawing stamp imprint).

B. In order to facilitate review of drawings, insofar as practicable, they shall be noted, indicating by cross reference the contract drawings, note, and/or specification paragraph numbers where item(s) occur in the contract documents.

C. Also provide PDF file shop drawings showing architectural reflected ceiling plans, coordinating locations of the following (to be verified by Contractor): Air distribution devices, sprinkler heads, lights and access panels.

D. See specific sections of specifications for further requirements.

1.17 AIR HANDLING UNIT AND DUCTWORK CONFIGURATION SHOP DRAWINGS

A. Contractor shall submit a shop drawing for each air handling unit. Such shop drawings shall meet the following requirements:

1. Be drawn at not less than a scale of 1/4" = 1'-0". Contractor may elect to use a larger scale if he desires (i.e., if drawing of unit is at 1/4" = 1'-0", 1/2" = 1'-0" may be used.).
2. Clearly show all proposed ductwork configuration changes (sizes, routing, and similar differences) which are different in any respect from the Drawings. Extent of shop drawings shall show all ductwork to and from each unit beginning with and terminating at those points where ductwork is intended to remain unchanged as shown on Drawings.
3. Where proposed changes affect any other work such as structure, housekeeping pads, piping, equipment, electrical work or any other work, shop drawings shall clearly show those proposed changes.
4. Proposed changes shall be at no additional change in contract price.
5. Where Drawings show units in plan only, shop drawings shall show proposed units in plan and also in elevation.
6. Shop drawings shall also show exact locations of related work (such as bar joists, columns, beams, sound attenuators, and like items) which affect the proposed ductwork routing and unit location and configuration.
7. Each section of each air handling unit shall be clearly identified (i.e., coil section, fan section, filter section, mixing box section, etc.).

B. Failure to submit these shop drawings together at the same time with the air handling unit shop drawings will result in total disapproval of the proposed air handling units. Time delays or other reasons will not be considered.

1.18 ELECTRONIC FILES

A. CADD files will be available on a limited basis to qualified firms. Recipients are cautioned that these files may not accurately show actual conditions as constructed. Users are responsible to verify actual field conditions. These files are not intended to be used as shop drawings.

1. A request for CADD files should be delivered in writing along with the Engineer of Record drawing release form by the contractor for such files. Files will not be processed until a signed release form is received.

1.19 OPERATING INSTRUCTIONS

A. Submit for checking a specific set of written operating instructions on each item which requires instructions to operate. After acceptance, insert information in each Technical Information Brochure. Refer also to other sections which may describe operating instructions.

1.20 MAINTENANCE INFORMATION

A. Submit for acceptance Maintenance Information consisting of manufacturer's printed instruction and parts lists for each major item of equipment. After acceptance, insert information in each Technical Information Brochure. Refer also to other sections which may describe maintenance.

1.21 MANUFACTURER'S CHECK-OUT

A. Check out by Manufacturer's Representative (for major items of equipment): At completion of construction and after performance verification information as above-mentioned has been gathered, submitted and accepted, provide one copy of this information to the manufacturer's representative. Work required under this section shall include having the representative examine the performance verification information, check the equipment in the field while it is operating, and sign a Check-Out Memo for record. Submit a copy of the memo on each major item of equipment for each brochure. Accepted memos shall be inserted on each brochure with the performance verification information and submittal data. Memos shall be submitted and accepted before Instruction in Operation to Owner or a request for final inspection.

1.22 SYSTEM GUARANTEE

A. The work required under Division-23 shall include a one year guarantee. This guarantee shall be by the Contractor to the Owner to replace for the Owner any defective workmanship, equipment, or material which has been furnished under this Contract at no cost to the Owner for a period of one year from the date of acceptance of the System. This guarantee shall also include reasonable adjustments of the system required for proper operation during the guarantee period. Explain the provisions of guarantee to Owner at the "Instruction in Operation Conference".

1.23 INSTRUCTION TO OWNER

A. Submit all required items for checking one week before final inspection of the building is scheduled. When all items are accepted and placed in the proper brochures, the Contractor shall give notice in writing that he is ready to give the Owner an "Instruction in Operation Conference". After the above mentioned request is received the Contractor will be notified of the time the conference can be held with the Owner. At the conference, the Contractor shall review with the Owner all appropriate information. At the end of the conference, seven copies of a memo certifying Instruction in Operation and Completed Demonstration shall be signed by the Contractor, Subcontractor and Owner and one copy inserted in each brochure.

1.24 MATERIALS AND EQUIPMENT

A. Each bidder represents that his bid is based upon the materials and equipment described in this division of the specifications.

1. Submittal shall include the name of the material or equipment for which it is to be substituted, substituted equipment model numbers, drawings, cuts, performance and test data and any other data or information necessary for the Architect/Engineer to determine that the equipment meets all specification and requirements. If the Architect/Engineer accepts any proposed substitutions, such acceptance will be set forth in writing.

2. Substituted equipment with all accessories installed or optional equipment where permitted and accepted, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether accepted or not, shall be replaced at the Contractor's expense. Any modifications of related systems of this or other trades as a result of substitutions shall be made at the Contractor's expense, and Contractor shall so state in his written request for substitution.

1.25 ACCEPTABLE MANUFACTURERS

A. Acceptable Manufacturers: Materials and Equipment specified in these contract documents are accepted only in regards to general performance and quality. It shall be the Contractor's responsibility to ensure that acceptable materials and equipment meet or exceed the efficiencies, capacities, electrical characteristics, performance and quality of the equipment herein specified. Acceptable equipment must also generally conform, without extensive modification of related systems to the accessories, weights, space and maintenance requirements, etc., of the specified equipment. Any modification to related systems of this or other trades shall be made at the Contractor's expense and the Contractor shall be responsible for coordination between trades. Any difference in capacity, efficiency, electrical characteristics, weights or quality of product, etc., between specified materials and equipment and acceptable alternates shall be submitted to the Architect/Engineer for acceptance within 30 days of Notice to Proceed.

1.26 COMMISSIONING

A. The Owner, under separate contract, will provide an independent commissioning firm for this project as specified in this section. General provisions and mechanical, plumbing and electrical systems are specified in Divisions 23 and 26. The contractor shall include all required participation, labor and material as required in the pre-commissioning and commissioning process.

B. This section covers building commissioning activities and documentation in support of the U.S. Green Building Council (USGBC) LEED™ rating program.

1. Commissioning activities and documentation for the LEED™ section on “Energy and Atmosphere” prerequisite of “Fundamental Building Systems Commissioning”.

C. The Owner, Architect/Engineer, and Commissioning Provider are not responsible for the construction means, methods, job safety, or management function related to commissioning on the job site.

D. Commissioning is the systematic process of ensuring that all building mechanical and electrical systems perform interactively according to the Owner's Project Requirements (OPR) and the operational requirements specified in other Divisions. The Commissioning Provider shall oversee and coordinate equipment start-up, system performance, testing, adjusting, and balancing, control system calibration, construction and system documentation, and Owner training.

E. Systems Being Commissioned:

1. HVAC components and equipment.
2. HVAC system: interaction of cooling, heating, and comfort delivery systems.
3. Building Automation System (BAS): control hardware and software, sequences of operations, and integration of factory controls with BAS.
4. Plumbing: Domestic hot water systems.

5. Lighting Control System and interface with daylighting.
6. Food Service Ventilation Systems.

1.27 COMMISSIONING PROCESS

A. The primary role of the Commissioning Provider shall be to develop and coordinate the execution of a commissioning plan; observe and document the installation, check-out, start-up, and equipment and system testing to establish that equipment and systems are functioning in accordance with the requirements of the construction documents; and to assist in developing correct and complete documentation of the construction effort. The Commissioning Provider shall not be responsible for design concept, design criteria, compliance with codes, design, construction scheduling, cost estimating, construction management, or construction supervision. The Commissioning Provider may assist the design team with problem-solving, or the Contractor with the correction of non-conformance items or deficiencies. The Commissioning Provider is not responsible for providing tools required to start, check-out and perform functional tests of equipment and systems, except for specified testing with supplemental portable data-loggers, which shall be supplied and installed by the Commissioning Provider.

B. The commissioning agent shall perform a formal review of the construction documents at 100% CD level and provide feedback on the design. Specific topics of review shall include the projects ability to comply with LEED commissioning criteria and individually components and devices that would be required to execute the commissioning and M&V scope of work.

C. Construction Phase: ensure that the Project requirements, as defined by the construction documents, are met, and achieve the following specific objectives:

1. Within 90 days of commencement of construction, schedule, plan, and conduct a commissioning scoping meeting to review the commissioning process and the draft commissioning plan and schedule with the commissioning team. With the input of the commissioning team, revise the draft commissioning plan and develop the working commissioning schedule.
2. Coordinate and direct the commissioning activities in a logical, sequential, and efficient manner using centralized documentation, periodic communications, and consultations with the commissioning team. Schedule additional commissioning meetings to plan, scope, coordinate, schedule future activities, and resolve problems throughout construction. Commissioning meetings shall initially be scheduled monthly until pre-functional testing of equipment and systems begins, and weekly thereafter. Record and distribute the meeting minutes for commissioning meetings.
3. Be responsible for the continuing updating, maintenance, revision, and coordination of the commissioning activities as construction progresses and coordinate the commissioning work and, with the Contractor, ensure that commissioning activities are included in the master project schedule.
4. Review submittals applicable to systems being commissioned, including the Contractor’s proposed detailed start-up procedures, concurrent with the Engineer's reviews and provide comments to the Engineer and the Owner. The Commissioning Provider’s review shall be for compliance with commissioning needs, and to aid in the development of functional testing procedures and only secondarily to review for compliance with equipment specifications; the design professional remains responsible for interpretation of compliance with contract requirements.
5. Request and review additional information as required to perform the assigned commissioning tasks, including review of operations and maintenance materials, and Contractor start-up and check-out procedures.
6. Develop specific Functional Performance Test procedures and forms to document the proper operation of each piece of equipment and system. Submit the proposed

functional tests to the Engineer for review and general conformance to the requirements of the contract documents and provide a copy of the proposed functional performance test procedures to the Contractor who shall review the proposed tests for feasibility, safety, equipment and warranty protection. Required performance testing may include control system trending, stand-alone data logger monitoring, and/or manual logging of system operation to demonstrate proper operation.

Functional Performance Test forms shall include (but not be limited to) the following information:

a. Date.
b. Project name.
c. System and equipment or component name(s).
d. Equipment location and identification number.
e. Unique test identification number, and reference to unique pre-functional checklist and start-up documentation identification numbers for the piece of equipment.
f. Participating parties.
g. A reference to the specification describing the specific sequence of operations or parameters being tested or verified.
h. Formulae used in calculations.
i. Required pre-test field measurements.
j. Instructions for setting up the test.
k. Special cautions or alarm limits.
l. Specific step-by-step procedures to execute the test, in a clear, sequential, and repeatable format.
m. Acceptance criteria of proper performance with provisions for clearly indicating whether or not proper performance of each part of the test was achieved.
n. A section for comments.
o. A signature and date block for the Commissioning Provider and participating parties.

7. Review the Contractor's start-up and pre-functional testing reports and provide on-site observation of start-up and pre-functional testing as specified herein.
8. Review the proposed testing, adjusting, and balancing execution plan for completeness and requirements of the commissioning process and provide comments to the Contractor, Engineer, and Owner.
9. Perform site visits, monthly until pre-functional testing of equipment and systems begins, and then weekly through the completion of the Project, to review component and system installations. Concurrently, schedule and conduct commissioning planning and coordination meetings to review the construction progress and to assist in resolving discrepancies or issues relating to the commissioning process.

D. Acceptance Phase: demonstrate that the performance of the equipment and systems installed during the construction phase meets the requirements of the construction documents. Notify the Owner and Engineer of deficiencies in results or procedures. Commissioning activity shall achieve the following specific objectives:

1. Witness 100% of the HVAC piping testing and flushing procedures.
2. Witness 100% of any ductwork testing and cleaning procedures.
3. Witness 10% the first of the pre-functional test procedures for each type and/or size of equipment.
4. Oversee the check-out, calibration, and functional testing of the control system and approve it for use for the testing, adjusting, and balancing effort before the test and balance procedures begin.
5. Oversee the test, adjust, and balance process by observing, at a minimum, the first test of each system type (e.g., air handling units, diffusers and grilles, terminal units, pumps),

and spot testing of subsequent equipment, sufficient to be confident that proper procedures were followed, and review of the Contractor's completed reports.

6. Coordinate, witness, and approve functional tests of equipment and systems performed by the Contractor. Review functional test reports and analyze any trend logs, data logger reports, and other monitoring data to evaluate equipment and system performance. Document the performance of the functional testing and provide a comparison to the required performance, as defined by the construction documents.
7. Coordinate retesting as necessary until satisfactory performance is demonstrated.
8. Maintain a master deficiency and resolution log and a separate testing record and provide written progress reports and test results with recommended corrective actions for observed deficiencies.
9. Compile and submit a commissioning report to the Owner and Engineer documenting the results of the Start-Up, Pre-Functional Performance Testing, and Functional Performance Testing.
10. Review the Contractor's proposed training of the Owner's operating personnel, and provide comments to the Engineer and Owner.
11. Coordinate and attend the Contractor-provided training sessions. Verify that the approved training has been properly completed.

E. Warranty period: assist the Owner in identifying defects in the installed equipment or system operation and in accomplishing the following specific objectives:

1. Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.
2. Verify that warranty items have been corrected properly.
3. Coordinate and supervise required seasonal or deferred testing and deficiency corrections, as specified or required by the commissioning plan.
4. Return to the site, approximately 10 months into the warranty period and review with the Owner the current building operation and the condition of outstanding issues related to the original and seasonal commissioning. Assist the Owner in reviewing the failure and repair records of equipment during the warranty period and in the evaluation of the Contractor's corrective actions. Identify areas that may come under warranty or under the original construction contract. Interview the Owner and identify problems or concerns regarding operating the building as originally intended and shall make suggestions for improvements. Assist the Owner in developing reports, documents, and requests for services to remedy outstanding problems.

PART 2 - PRODUCTS

2.1 Section part not applicable.

PART 3 - EXECUTION

3.1 Section part not applicable.

END OF SECTION 23 01 00

SECTION 23 02 00
ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Basic Requirements: Provisions of Section 23 01 00, BASIC MECHANICAL REQUIREMENTS are part of this Section.

1.2 SUMMARY

A. General: Provide electric motors and related electric material and equipment required for all mechanical work.

1.3 SUBMITTAL

A. General: Refer to paragraph entitled "SUBMITTAL" in Section 23 01 00. Include the following material and performance data:

1.4 APPLICABLE STANDARDS

A. General: All equipment, material, accessories, methods of construction and reinforcement, finish quality, workmanship and installation shall be in compliance with the paragraph entitled "Code Compliance" in Section 23 01 00.

B. Comply: With the National Fire Protection Association (NFPA) Standards and other Codes and Standards as adopted by the Local Authority having Jurisdiction.

1. NFPA: NFPA-70, National Electrical Code, latest edition adopted by the Florida Building Code
2. NEMA: National Electric Manufacturer's Association Standard MG-2.

PART 2 - PRODUCTS

2.1 ELECTRIC MOTOR

A. Manufacturers:

1. General Electric.
2. Westinghouse.
3. Baldor Electric Co.
4. Emerson.
5. Lincoln.

B. General:

1. Provide motors for continuous duty conditions in which they will be required to perform; i.e., general purpose, splash-proof, explosion proof, standard load, high

torque, or any other special type as required by the equipment motor manufacturer's recommendations. Unless otherwise indicated or required, motors shall be open drip-proof type.

2. Motors installed outdoors shall be totally enclosed fan cooled (TEFC) type.
3. Motor enclosures shall be of the type recommended by the equipment manufacturer for the specific application.
4. All motors shall be furnished for starting in accordance with electric utility company's requirements and shall be compatible with the motor starter and driven load. Motors shall not exceed full-rated nameplate load when operated at any point along the driven equipment's characteristic performance curve. The motor service factor shall not be used to justify exceeding nameplate amperage.
5. Motors designated to operate with a variable frequency drive shall be approved by the manufacturer of the variable frequency drive equipment and the manufacturer of the motor to insure quiet and stable continuous operation over the entire speed range.
6. Verify the circuit voltage and phase being furnished to the motor. All motors shall be 1750 rpm unless noted otherwise. Motors shall operate with electrical input voltage variations of plus or minus 1 percent of nameplate rating or frequency variations of plus or minus 5 percent of nameplate rating.

C. Design: Provide NEMA Design B for normal starting torque with Standard MG1-12.42 Class B insulation unless noted otherwise or required by the equipment on which the motor is being used, except that motors for variable-speed service shall have Class F insulation. Motors shall be designed for operation in 40 degree C. ambient at 1.23 service factor on sine wave power at the base voltage and frequency and shall have all copper windings. Motors shall meet or exceed the locked-rotor (starting) and breakdown (maximum) torques for the NEMA rating. Locked rotor current shall not exceed 6 times full-load current. Motor current density and heating characteristics shall be such that the motor insulation will not fail if subjected to locked-rotor current for 20 seconds.

D. Efficiency: Motors 1 horsepower and larger shall be high efficiency design. Nominal efficiency of each motor shall be tested in accordance with NEMA MG 1-12.54.1 and shall be labeled on the motor nameplate in accordance with NEMA MG 1.12.54.2.

2.2 MOTOR STARTERS

A. Compliance: Motor starters included as an integral part of a factory pre-wired control panel shall be provided by the manufacturer of the equipment it serves. All motor starters shall comply with the requirements of Section titled "MOTOR CONTROLLER" in Division 26.

B. Overload Protection: Unless otherwise indicated, all 3 phase motor starters shall be provided with thermal overload relays on each phase sized in accordance with the actual nameplate full load ampere rating. Single-phase motors shall be furnished with built-in thermal protection.

C. All motors starters for mechanical equipment shall be provided under Division 23. Provide HOA type motors starters with pilot lights and auxiliary contacts for interlock/interface operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Material and Equipment: Install material and equipment in accordance with details shown on the drawings, submittal drawings and manufacturer's instructions.

3.2 WIRING

A. Power: All power wiring shall be installed according to the requirements of Division 26, ELECTRICAL.

B. Interlock: Unless otherwise noted, all interlock wiring, such as remote line voltage thermostats, fan speed controllers, etc. shall be installed by the supplier of that equipment. Interlock wiring shall be installed according to the requirements of Division 26, ELECTRICAL.

C. Control: All control wiring exposed in mechanical equipment rooms, fan rooms, return air plenums, etc. shall be in rigid conduit.

END OF SECTION 23 02 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 05 00
BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section, in addition to the following:

1.2 SCOPE

A. Materials listed herein are general mechanical materials to be used under the Division 22 and 23 sections of the specifications unless specifically noted otherwise in the particular section or on the drawings.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 22 and 23 and to all other applicable portions of the Drawings and Specifications. This section relates to all sections of Division 23 as may be applicable to the work of each section.

1.4 STANDARDS

A. Quality and weight of materials shall comply with requirements and specifications of the appropriate standards of the American Society of Testing and Materials.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT, GENERAL

A. All materials and equipment shall be new and without blemish or defect.

B. Equipment and materials shall be products which will meet with the acceptance of the agency inspecting the work. Where acceptance is contingent upon having the products examined, tested and certified by Underwriters Laboratory or other recognized testing laboratory, the product shall be so examined, tested and certified.

C. Where no specific indication as to the type or quality of material or equipment is indicated, a standard item or system shall be furnished with all options, features and capabilities to meet the project requirements.

D. Performance and Capacity:

1. Performance as delineated in schedules and in the specifications shall be interpreted as minimum performance. In some cases equipment may be sized to allow for future

requirements or for other reasons which may not be stated on the Drawings or in the Specifications; provide equipment and systems with the capacities, capabilities and features indicated to provide the maximum or minimum (as appropriate) conditions.

E. Operating conditions and capacities must be as follows:

1. No overloading.
2. No operation at conditions outside of maximum and minimum limits recommended by the manufacturer and accepted by the Architect/Engineer.
3. Compatible with all systems.

F. Unless otherwise specified, all equipment and materials furnished must be as follows:

1. Recommended by the manufacturer for the application.
2. Installed in accordance with the manufacturer's recommendations for the application except where specifications and drawings clearly indicate otherwise.

2.2 ACCESS DOORS AND PANELS

A. Locations: Provide access doors and panels (access units) as necessary for access to items which are concealed and which may require service or maintenance or other reason for accessibility. Examples of such items include, but are not limited to, the following: valves, cleanouts, pipe unions, expansion joints and connectors, dampers, coils, junction boxes, duct heaters, terminal units, HVAC control system devices and similar types of items.

B. Access units: Shall be manufactured by the Milcor Division of Inland-Ryerson, Boico, Nystrom or Ventfabrics. Types are as follows (Milcor style designations are used for example only):

Location	Door/Panel Type
Drywall	Style "DW"
Masonry or tile	Style "M-stainless"
Acoustical tile	Style "AT"
Plaster	Style "K"
Fire-rated walls	Style "Fire Rated"**
(**or as indicated below)	

C. Fire Rated Units:

1. Frame and panel assembly shall bear a U.L. label reading, "frame and door assembly, rating 1-1/2-hour (B), temperature rise 30 minutes 250^{o}F maximum".
2. Have an automatic closing device and mechanism to release the latch bolt from the inside.
3. Acceptable Manufacturers: Boico Style F, Inryco/Milcor Style VA, Nystrom Style APFR.

D. Non-fire Rated Units:

1. Steel panels and frames.
2. Locks and latches shall be as appropriate for the location and shall be cam-lock type latches, flush screw driver operated locks or cylindrical locks.
3. Provide two keys for all doors. All doors shall be keyed the same.

E. Other Requirements:

1. Doors and panels installed in glazed or ceramic tiled surfaces, in toilet rooms or in kitchens shall be stainless steel.
2. Unless otherwise indicated, finish shall be rust inhibitive prime coat.

F. Sizes:

1. Minimum size: 8" x 8".
2. Sizes of each unit shall be individually selected to allow the recommended and required service and maintenance and accessibility functions to be accomplished. These functions shall generally include, for example, valve removal, damper linkage resetting, control adjustment, lubrication, repair, replacement and similar tasks as may be necessary and recommended for the concealed item.
3. Sizes shall be of the following increments (unless otherwise approved) to allow the accessibility function to be accomplished: 8" x 8", 8" x 12", 12" x 12", 12" x 16", 16" x 16", 16" x 24", 24" x 24", 24" x 36", 30" x 30", 36" x 36" or 36" x 48".
4. No size smaller than 16" x 24" shall be allowed when a person must pass through the access opening in order to accomplish the desired accessibility function.
5. Every attic or furred space in which mechanical equipment is installed shall be accessible by an opening and passageway as large as the largest piece of the equipment and in no case less than 22 x 36 inches continuous from the opening to the equipment and its controls. The opening to the passageway shall be located not more than 20 feet from the equipment measured along the center line of such passageway.

2.3 PAINTING AND MARKING

A. All paint and materials used for painting shall be manufacturer's "first quality" product. For additional paint material requirements, refer to Section 09 91 01, Painting.

B. Marking: Refer also to sections describing identification of mechanical systems.

2.4 PIPE HANGERS AND SUPPORTING DEVICES

A. General: Refer to other sections of Division 23 for any requirements which may be additional to this section. Comply with the more stringent requirement if more than one method is specified or shown.

B. Pipe supporting devices specified herein shall apply to all Division 22 and 23 piping unless modified in subsequent sections of Division 22 and 23 (i.e., vibration isolation) or detailed on the drawings.

1. Pipe hangers for copper pipe shall be copper or copper-plated and for steel pipe shall be zinc-plated, clevis type hangers.
2. Hangers for pressure piping shall be clevis type or accepted as equivalent. Pipe hangers shall be capable of vertical adjustment after erection of the piping. Piping shall not be hung from fire and/or smoke walls.
3. Vertical piping supports shall be constructed of carbon steel with rounded ears and two or four holes for clamping bolts. Steel, galvanized and cast iron piping riser clamps shall have galvanized finish. Copper and brass piping riser clamps shall have electro-plated copper or PVC coating finish.
4. Acceptable Manufacturers are Grinnell, PHD Manufacturing Inc., Fee and Mason, Michigan and Elcen.

C. Beam clamps may be used when supporting piping from steel structures.

D. Concrete inserts shall be placed in forms as work of Divisions 22 and 23 prior to the time that concrete is poured.

E. Lead tamp-ins may be used when installed in a concrete or masonry wall or other like vertical surface to support a vertical hanger. Lead tamp-ins will not be permitted to support hangers to the underside of a concrete slab.

F. For parallel runs of above ground suspended piping, an acceptable trapeze-type hanger may be used. Provide permanent, non-conductive type wrapping between copper pipe and steel trapeze hangers.

G. Powder set type fasteners or inserts shall not be used.

2.5 FLOOR, WALL OR CEILING PLATES OR ESCUTCHEONS IN EXPOSED AREAS

A. Shall be chrome-plated. Escutcheons for extended sleeves shall be of the type designed for that purpose. Split ring escutcheons will not be allowed.

B. Escutcheons to be as manufactured by Guarantee Specialty Mfg. Co., Cleveland, Ohio; American Sanitary Mfg. Co., Abingdon, Ill., or Beaton Cadwell.

C. Provide escutcheons or fabricated plates or collars at each location where pipe or duct passes through a finished surface. Escutcheons for flush sleeves shall be equivalent to Benton & Caldwell No. 3A chromium plated brass; for sleeves extending above floor shall be equivalent to Benton & Caldwell No. 36 chrome plated brass. Collars or plates for ducts and large diameter insulated pipe shall be fabricated of 18 gage galvanized copper bearing sheet steel, secured to structure and neatly fitted around duct or pipe.

2.6 SLEEVES

A. General: Lay out work and set sleeves in new or existing construction so there shall be minimum of cutting, drilling and patching. All sleeves not used during construction period shall be sealed using grout. Unused penetrations or sleeves through fire rated barriers shall be sealed to prevent passage of smoke or heat using an Underwriters' Laboratories approved method rated at least equivalent to the barrier being penetrated. Method submitted must show proof of UL approval.

B. Pipe Sleeves: Except where specified otherwise below, pipe sleeves shall be as follows:

1. Sleeves installed in walls subject to hydrostatic (water) pressures shall be "link seal" (Thunderline Corp) Type WS or accepted as equivalent.
2. When there is piping existing, and fire rated walls are to be erected, Proset fire rated split wall system pipe sleeves, or accepted equivalent, are to be used.
3. When copper or steel slab penetrations are required, use Proset System A, or accepted as equivalent for fire-rated and water pipe installations.

C. Walls and Partitions:

1. Sleeves 8-Inch Diameter and Smaller (Above Grade): Sleeves shall be mild steel pipe or plastic sleeves built into wall, partition or beam, sized to pass pipe and covering, leaving a clear space of 1/4-inch minimum between covering and sleeve. Penetrations of fire rated barriers shall have mild steel sleeves.

2. Sleeves Installed in Exterior Walls (Below Grade): Schedule 40 steel hot dipped galvanized after fabrication or cast iron sleeve with 1/4-inch x 3-inch center flange (water stop) around the outside.

D. Floors (Above Grade): Sleeves shall be Schedule 10 galvanized steel, set before floor is poured, sized to pass pipe and covering, leaving a clear space of 1/4-inch between covering and sleeve, and shall extend ½-inch above finished floor.

E. Duct Sleeves: Sleeves or openings sized to pass mechanical ducts and covering shall be of framed construction in roof, wall, or partitions.

F. Sealing of Sleeves:

1. Sleeves Below Grade: Caulk annular space between pipe and sleeve using oakum and poured lead both sides minimum one inch deep to make wall penetration water tight.
2. Sleeves Above Grade: Openings around pipes, duct, etc., passing through sleeves shall be made draft free and vermin-proof by packing solidly with mineral wool or fiberglass.
3. Sealing of Sleeves Through Fire Rated Barriers: All penetrations through fire rated barriers shall comply with Division-07 or as specified in this Division.

2.7 FIRE/SMOKE RATED FLOOR, PARTITION OR WALL PENETRATION SEALANT

A. Seal shall be composed of fire barrier product, putty, or caulking materials used either in combination or singularly. Acceptable Manufacturers are 3M Corporation or Dow Corning.

2.8 STEEL SUPPORT FRAMING FOR EQUIPMENT

A. Provide as necessary, all steel and hardware for any equipment requiring a steel support frame assembly. All welding and fabrication shall be submitted based upon the actual equipment purchased and shall be sized to accommodate the weight of the equipment, vibration and point loads. All steel shall be primed and painted prior to installing the equipment on the support frame.

2.9 EXCAVATION AND BACKFILL

A. Provide as necessary to accomplish work specified. Perform in accordance with applicable State and Local codes and accepted good practice and in accordance with other applicable sections or divisions.

2.10 BELT DRIVES

A. General: Equip each motor driven machine not direct connected with V-belt drive. Belts shall be of correct cross section to fit properly in sheave grooves and shall be carefully matched for each drive. Sheaves shall be cast iron or steel, bored to fit properly on shafts and secured with keys of proper size. The rating of each drive shall be as recommended by manufacturer for service but shall be at least 1.5 times nameplate rating of motor.

B. Speed Adjustment: Adjust fan speed by change(s) in sheave size as necessary to obtain proper design air flow with fan in its installed location. Fans may be first fitted with variable pitch drives until proper speed adjustment is made and then fitted with proper fixed pitch drive size, or alternate sizes of fixed pitch drives may be used until proper fan needed to deliver necessary air quantity.

C. Vibration of Air Handling Equipment and Fan Units: For air handling equipment and fans driven by motors 5-hp or greater, field vibration levels will not be acceptable if the maximum vibration velocity or displacement measurement exceeds the following values (when measurements are taken at the bearing supports using a vibration analyzer with the filter set at the operating fan speed):

Fan Speed (RPM)	Maximum Vibration Level
800 or Less	5 Mils (0.127 mm) max. displacement
801 and Greater	0.20 in/sec. (5 mm/s) max. velocity

D. Belt and Coupling Guards: Each belt drive shall be equipped with an OSHA approved guard. Guards shall be constructed of #12 U.S. standard gage 3/4-inch diamond mesh wire screen, or equivalent, welded to one inch steel angle frames, and shall enclose all belts and sheaves. Tops and bottoms of guards shall be of substantial sheet metal or not less than #18 U.S. standard gage. Braces or supports must not "bridge" sound and vibration isolators. Guards shall be designed with adequate provision for movement of motor required to adjust belt tension. Means shall also be provided to permit oiling, use of speed counters, and other maintenance and testing operations with guard in place. All direct drive equipment shall have coupling guards in accordance with Florida Department of Business Regulation safety regulations and OSHA.

2.11 BEARINGS

A. All bearings shall be 200,000-hour rated unless otherwise specified.

PART 3 - EXECUTION

3.1 EQUIPMENT ACCESS

A. Access Doors and Panels:

1. Locations: Provide access unit at the following locations.

   a. Where additionally specified in other sections of this Divisions 22 and 23 and where specifically indicated on the drawings.
   b. Where not specifically indicated on the drawings but where the work to be provided will require accessibility for purposes as described or as recommended by the manufacturer of the concealed item.
   c. At all locations where concealed equipment, fixtures, devices and similar items require accessibility for service, inspection, maintenance, repair, replacement and where such concealed item would not otherwise be accessible for such functions without the provision of an appropriately sized access unit.

B. Installation:

1. Definitions: For the purpose of coordination of responsibility, the following words are defined to describe the intended coordination.

   a. "Furnish" means to procure an item and deliver it to the project for installation.
   b. "Install" means to determine (in coordination with others as necessary) the intended appropriate location of an item and to set, connect and otherwise fix in place in a manner to allow intended operation and use.

c. "Provide" means to both furnish and install fully and completely in all aspects.

2. Furnishing Access Units: Access units shall be furnished as work of the Division which governs the item which is intended to be made accessible by the access unit.
3. Installing Access Units: Access units shall be installed as work of the Division which governs the surface, barrier, partition or other building component in and on which the access unit is to be placed.
4. Determination of Locations:

   a. Where the work of Divisions 22 or 23 requires that the access unit be provided (i.e., both furnished and installed), then the responsibility for determination of the location at which the access unit is to be placed is also work of Divisions 22 and 23.
   b. Where the work of Divisions 22 or 23 requires that access unit be furnished for installation as work of another Division, then the responsibility for determination of the location at which the access unit is to be installed shall be work of Divisions 22 and 23. Conversely, where the work of one Division requires that an access unit be only installed, then the responsibility for determination of the location of which the access unit is to be installed shall be work of Divisions 22 or 23 which furnishes the access unit.

5. Determination of Sizes:

   a. Unless an access unit size is indicated on the drawings or otherwise specified, the size of each access unit shall be determined as work of the Division which either provides or furnishes the access unit.
   b. Sizes for access units which are provided or furnished as work of this Division shall be in compliance with sizing criteria of this Division.

3.2 PAINTING

A. Paint all exposed piping, insulation, equipment, structural bases, racks, in equipment rooms and on roof, furnished under Divisions 22 and 23 of these specifications. All exposed metal surfaces shall be given one prime coat and two finish coats. All insulated surfaces shall be given one sizing coat of glue sizing (omit this step if factory applied finish is suitable to receive prime coat), one prime coat and one finish coat. Factory painted or finished items do not require field painting but shall require "touch-up" with matching paint or finish where scratched.

B. Pipe hangers, saddles, supports, riser clamps and accessories shall be painted to match their piping.

C. Equipment not completely accessible for painting when set in place shall be thoroughly cleaned and painted before installation and suitably protected.

D. Piping concealed need not be painted.

E. All Mechanical room concrete equipment pads shall be painted yellow enamel, minimum of two coats.

3.3 HANGERS AND INSERTS

A. Refer also to other sections which may describe additional requirements for hanging and supporting. Comply with the more stringent requirement if more than one method is specified or shown.

B. Provide and properly locate hangers to adequately support piping and equipment. Arrange hangers to permit expansion and contraction.

C. The size of hanger for non-insulated pipes shall be suitable for pipe size to be supported. For insulated piping, the size of the hanger shall be suitable for the pipe size, plus the insulation and a 16-gauge half-circle galvanized sheet metal insulation saddle.

D. Isolation of copper pipe from steel hangers to consist of wrapping pipe at, and 1" each side of contact surface with not less than two layers of adhesive type plastic electrical insulating tape.

E. Pipe supports for piping 2" diameter and below may be supported directly from Epicure steel decking using Epicure standard hangers (200 lb. max. load). Piping above 2" shall be supported from steel beams.

F. Locate pipe supports as follows unless noted in other sections of these specifications or on the drawings:

1. Horizontal cast iron pipe inside building - supported on each length of pipe.
2. Vertical cast iron pipe inside building - supported at each floor level and at the base.
3. Horizontal steel piping and copper tubing 1" diameter and under - support on 6' centers.
4. Horizontal steel piping and copper tubing above 1" through 1-1/2" diameter - support on 8' centers.
5. Horizontal steel piping and copper tubing larger than 1-1/2" diameter -support on 10' centers, except 24" diameter piping shall be supported by main roof beams (20' O.C. maximum).
6. Support vertical cast iron, steel and copper piping at each floor penetration not to exceed 20 foot intervals.

3.4 ANCHORS

A. Install a suitable anchor on piping to prevent movement from expansion and contraction by welding or clamping securely to pipe at fitting or coupling. Approval of the Architect/Engineer of method of anchorage must be obtained before installation of work. Properly anchor piping to remove strains on equipment which would be caused by expansion and contraction. Adequately insulate anchors on piping, with operating fluid temperatures below 75^{o}F, to prevent moisture condensation problems.

3.5 EXPANSION AND CONTRACTION PROVISIONS

A. Piping is designed with offsets and loops to provide for expansion and contraction. At such points, piping shall be cold sprung to equalize expansion when at operating temperatures. Install piping to maintain grade at all operating temperatures.

3.6 FLASHING

A. Flashing shall be done as work of other divisions.

3.7 PIPING SLEEVES

A. Contractor shall furnish and set sleeves for his piping. Use galvanized sheet steel with water tight seams and joints or pipe for poured concrete. Extend sleeves thru walls, partitions and

ceilings to finished surface. Extend sleeves 1/4 inch above finished concrete floors and 1 inch above slab in chases. Sleeves, installed above finished ceilings, for fire/smoke rated wall assemblies shall extend 1" beyond each face of wall.

B. Adequately size sleeves to permit clearance for pipe movement and proper grading of pipes. Sleeves for insulated pipe shall be of adequate size to clear insulation.

C. Caulk space between insulation or pipe and sleeve with asbestos rope and seal with fire rated safing material (or flexible fire retardant sealant if pipe is subject to expansion or contraction) to serve as a fire and smoke stop.

D. Sleeves in walls and/or slabs subject to hydrostatic pressures shall be made water tight.

3.8 ESCUTCHEONS

A. Provide chrome plated brass escutcheons (for 1/4 or 1 inch projecting sleeves as required) at each point where an un-insulated pipe passes thru a finished surface.

3.9 CONCRETE BASES AND STRUCTURAL STEEL

A. Concrete bases and structural steel to support equipment and piping installed under each specification section or division and not specifically shown on the structural or architectural plans shall be furnished for this work.

3.10 SEALANT

A. Fire/smoke sealant shall be installed in strict compliance with the manufacturer's installation instructions.

END OF SECTION 23 05 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 05 15
INSTRUCTIONS AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Provide complete written and verbal operating and maintenance instruction to the Owner for all mechanical systems.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Divisions 22 and 23 and to all other applicable portions of the Drawings and Specifications.

B. This section directly relates in particular to sections which describe the following:

1. Valves and piping systems components requiring maintenance and which are involved in the dynamic function of the systems.
2. Pumps and related flow devices.
3. Plumbing equipment (water heaters, packaged systems, etc.)
4. HVAC equipment (all chillers, air handling equipment, terminal units, filter assemblies, etc).
5. Control systems.

PART 2 - PRODUCTS

2.1 INSTRUCTIONS AND MAINTENANCE MANUALS

A. Provide three Instructions and Maintenance Manuals, each complete as follows:

1. Hardback three-ring loose-leaf binders.
2. Title sheet with job name, Contractor's, subcontractor's control subcontractor and related contractor's or material supplier's names, addresses and phone numbers.
3. Index of contents.
4. A signed copy of acknowledgment of instructions to the Owner or his authorized representative. Two additional copies of the signed acknowledgment shall be sent directly to the Architect as soon as possible after receipt.
5. Typewritten operating instructions for the Owner's personnel describing the following for each piece of equipment and systems:

    a. How to start and stop each piece of equipment.
    b. How to set equipment and systems for normal operation.

c. Normal restarting procedures before contacting the service contractor.
d. Complete description of functions and operations of each piece of equipment including description of how equipment operates in conjunction with automatic control systems.
e. Instructions for cleaning, oiling, greasing, fueling and similar tasks.

6. Approved shop drawings and submittal data and parts and maintenance booklet for each item of material and equipment furnished under this Division, including (but not limited to) the following:

a. Spare parts list and source of supply for each equipment item.
b. List of valves with location, service, size, model and operating position.
c. Diagrams clearly indicating automatic control hook-up.

7. Any as-built wiring diagrams as called for in other sections of this division as needed to show how equipment controls interface with related systems.
8. Copies of certificates of inspection.
9. Guarantees/Warranties.

PART 3 - EXECUTION

3.1 VERBAL INSTRUCTION

A. Provide verbal, hands-on, operating and maintenance instruction to Owner's authorized personnel for each equipment item and system. Instruction shall be given by competent personnel.

1. Duration: Total instruction period for all systems of this Divisions 22 and 23 shall be not less than fifteen (15) working days. The Owner reserves the right to audio-tape or video-tape the instruction procedure.

3.2 MANUFACTURERS' SERVICE REPRESENTATIVES

A. Verbal instruction at the site for the following equipment items and systems shall be given jointly by the contractor and the authorized manufacturer's service representative. (Contractor and manufacturer's service representative shall provide instruction to Owner for each equipment item of no less duration than the hours indicated in parenthesis. Duration shall be greater if otherwise specified).

1. Air Handling Units (4 hours)
2. Exhaust Fans (2 hours)
3. Fan Coil Units (2 hours)
4. Terminal Units. (2 hours)
5. DDC Controls (refer to the DDC Control Specifications)

END OF SECTION 23 05 15

SECTION 23 05 16
HOUSEKEEPING PADS, CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Provide concrete housekeeping pads for the equipment listed in this section. This work shall be performed by the concrete installer.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Divisions 22 and 23 and to all other applicable portions of the drawings and specifications.

B. This section directly related in particular to sections (which may or may not be included in this division) which describe the following:

1. Concrete described in other divisions.

C. Painting: All housekeeping pads for equipment installed for Divisions 21, 22 and 23 shall be field painted with two coats of bright yellow enameled paint prior to setting of the equipment. Touch-up all painting after equipment has been completely installed.

PART 2 - PRODUCTS

2.1 GENERAL

A. All concrete and steel for concrete housekeeping pads shall comply with those sections of the specification division describing concrete and steel.

2.2 HOUSEKEEPING PADS

A. Provide reinforced (#4's @ 12" both ways with 1-1/2" top cover) concrete housekeeping pads for each individual machine. Pads shall extend six inches beyond the machine bases in all directions and be continuous beneath the machine. Pads shall have chamfered edges and shall be poured and finished smooth and level to insure proper and continuous support for the bearing surfaces of the machine.

B. Coordinate exact length and width of each pad and any penetrations which may be necessary for piping or conduit with the actual equipment approved for use on the project.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to the section describing vibration isolation for equipment which is to rest on concrete housekeeping pads.

B. Paint all equipment pads with two coats of yellow enamel paint prior to setting the equipment. Touch up painted surfaces after installation of the equipment, piping, etc.

3.2 PAD HEIGHTS

A. Provide 6" high concrete pads for the following:

1. All equipment specified or shown to be on a concrete pad if no height is given.
2. Indoor air handling units. (AHU's).
3. Floor mounted pumps.
4. Floor-mounted shot feeders.
5. Ground-mounted condensing units.

END OF SECTION 23 05 16

SECTION 23 05 18
PIPING: CONDENSATE DRAIN

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Provide condensate drain piping from cooling coil drain pans.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division-23 and to all other applicable portions of the Drawings and Specifications.

B. This section directly relates in particular to sections (which may or may not be included in this division) which describe the following:

1. Air handling equipment with cooling coils.
2. Insulation.
3. Chilled Water Pumps.

PART 2 - PRODUCTS

2.1 PIPE

A. Type M or Type L hard drawn copper conforming to ASTM Spec. B88.

2.2 FITTINGS

A. Wrought copper, solder joint, pressure type conforming to ANSI B16.22.

B. Pro-press fittings are acceptable.

2.3 SOLDER

A. Composition SB5 (95/5), Fed. Spec. QQ-S-571d and Class 3 (Sil Fos), Fed. Spec. AA-S-561d, ASTM B32.

PART 3 - EXECUTION

3.1 GENERAL

A. Piping shall be sloped uniformly toward drain, and provided with trap seal having a depth, in inches, equivalent to one and one-half (1-1/2) times the total static pressure of the respective fan system. Traps shall be assembled using elbows and tees with threaded brass plugs to permit cleaning of trap and drain line. Piping shall be installed in a neat manner and shall be not smaller than full size of the equipment drain connection or three-quarters inch (3/4") whichever is larger.

3.2 JOINTS AND CONNECTIONS

A. General: Joints and connections shall be made permanently air, gas, and water tight. Minimum condensate pipe size shall be ¾".

B. Solder Joints: Cut pipe square using cutting tool which does not crimp pipe. Remove all burrs using pipe reamer and taking care not to flare the pipe end. Thoroughly clean the outside of pipe and the interior of the fittings using a fine sand cloth. Apply non-corrosive paste flux to the cleaned surfaces immediately and apply solder and heat, in accordance with manufacturer's instructions, to complete joint.

C. Equipment Connections: Connections to copper drain nipples may be made with solder joints provided care is exercised not to damage equipment, its insulation or finish. Connections to equipment having steel nipples shall be made using screwed to solder adapters with teflon tape applied to male threads prior to assembly.

D. Chilled Water Pumps: provide ¾" drain line from the pan under each CHW Pump assembly and pipe to the nearest floor drain.

3.3 ROUTING

A. Unless otherwise indicated, route pipe discharge as follows:

1. Roof Mounted Equipment: To nearest roof drain.
2. Interior Equipment: To nearest floor drain.

3.4 INSULATION

A. Insulate if so specified in section describing insulation.

END OF SECTION 23 05 18

SECTION 23 05 29
HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE

A. Provide all angles, brackets, clamps, anchors, inserts, rods, braces, frames, hangers nuts and bolts, and other miscellaneous steel and hardware items as may be required for the proper support of equipment, piping systems, HVAC systems, plumbing systems and fire protection systems.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Divisions 22 and 23 and to all other applicable portions of the Drawings and Specifications.

B. This section directly relates in particular to sections (which may or may not be included in this division) which describe the following:

1. Piping systems.
2. Duct systems.
3. Equipment items.

1.4 SHOP DRAWINGS

A. Refer to Section entitled "General Mechanical Provisions". Provide specific data on hangers, stands, clamps, rollers, guides, shields, anchors and their proposed application. Submit detailed shop drawings, showing method of support and anchoring for all piping and equipment as follows:

1. Piping Systems:
2. Scaled single line piping plans superimposed on structural construction drawings. Scale shall be minimum 1/4" = 1'-0". Piping which is three inch (3") diameter and smaller may be omitted from these shop drawings. Drawings shall clearly indicate the location and type of each and every insert, hanger, stand, support, guide, isolator and anchor; and shall also indicate the size, type locations and method of attachment for all miscellaneous structural steel required.
3. Sectional drawings, sketches and other details as may be required to clearly communicate the method of support, anchoring, guiding and vibration isolation.
4. Show details of any typical floor or wall penetrations including: riser clamp, pipe sleeve, and provisions for water stop to prevent the water travel between penetrations.

1.5 INDUSTRY STANDARDS

A. Where compliance with an industry, society or association standard is specified or indicated, certification of such compliance shall be submitted with shop drawings.

1.6 MANUFACTURERS

A. Products listed in this Section or on the plans are based on a specific manufacturer to establish the desired style, quality and type. Equivalent products, complying with the requirements of this Section and the installation requirements of the plans, by the following manufacturers are acceptable:

1. F&S Manufacturing Corp.
2. Fee and Mason Manufacturing Co.

PART 2 - PRODUCTS

2.1 HANGERS

A. Hangers in Contact With Copper Piping: Shall be copper plated or teflon coated. Hangers shall be Fed. Spec. WW-H-171E, Type 9. Acceptable: Grinnell Fig. 97 or 97C, or equivalent.

B. Hangers (other than in Contact with Copper Piping): Shall have manufacturer's standard finish. Hangers shall be of the following types:

1. Pipe 3" and Larger: Fed. Spec. WW-H-171E, Type 1. Acceptable: Grinnell Fig. 260 or equivalent.
2. Pipe 2-1/2" and Smaller: Fed. Spec. WW-172E, Type 6. Acceptable: Grinnell Fig. 104 or equivalent.

2.2 ISOLATORS

A. Refer to the Section, if included in this Division, which describes vibration isolation.

2.3 PIPE ROLLER STANDS

A. Shall be Fed. Spec. WW-H-171D, Type 47. Acceptable: Grinnell Fig. 171, or equivalent.

2.4 PIPE ROLLER HANGERS

A. Pipe Roller Hangers: Shall be Fed. Spec. WW-H-171E, Type 42. Acceptable: Grinnell Fig. 171, or equivalent.

2.5 PIPE ALIGNMENT GUIDES

A. Acceptable: Grinnell Fig. 256, or equivalent.

2.6 PIPE RISER CLAMPS

A. Pipe Riser Clamps: Shall be Fed. Spec. WW-H-171D, Type 8.

2.7 INSULATION SHIELDS

A. Shall be Fed. Spec. WW-H-171D, Type 41. Acceptable: Grinnell Fig. 167, or equivalent.

2.8 BEAM CLAMPS

A. Fed. Spec. WW-H-171D, Type 29. Acceptable: Grinnell Fig. 292 with links, or equivalent.

2.9 INSERTS

A. Preset Type: Malleable iron with removable interchangeable nuts having lateral adjustment of not less than one and five-eighths inches. Continuous inserts shall have a capacity of 2,000 lb. per foot and shall be hooked over reinforcing. Acceptable: C-B Universal Fig. 282; Unistrut Products Co., P3200 or P3300; B-Line Systems, Inc., Series B- 32.1, or equivalent.

2.10 ROD

A. Carbon steel, black threaded bolt ends or continuous thread, sized with safety factor of five (5). Acceptable: Grinnell Fig. 140 or 146, or equivalent.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to Section entitled "General Mechanical Provisions". All inserts, fasteners, hangers and supports shall be installed in strict accordance with manufacturer's instructions.

3.2 PIPE

A. General: Hangers shall be spaced to prevent sag and to permit proper drainage. All piping shall be run parallel with the lines of building, unless otherwise indicated on drawings. The hanger spacing and placement shall be such that after the covering (insulation and finish) is applied, there will be not less than 1/2" clear space between finished covering and other surfaces, including the finished covering of parallel adjacent pipes. Hangers for insulated pipes shall be sized to encompass the insulation, finish and metal insulation shield (a metal insulation shield shall be provided for each hanger or support). Vertical piping shall be supported with pipe riser clamps at every floor penetration, unless specifically indicated otherwise on the drawings. Hangers and supports shall not be placed at greater than the following intervals:

B. Pipe 1" and Smaller: Eight foot (8') centers and not more than two feet (2') from a change in direction (offsets, elbows, and tees).

1. Pipe 1-1/4" through 2-1/2": Ten foot (10') centers and not more than two feet (2') from a change in direction (offsets, elbows and tees).

2. Pipe 3" and Larger: Fourteen foot (14') centers and not more than two feet (2') from a change in direction (offsets, elbows, and tees).

3.3 EQUIPMENT

A. Equipment supports shall be as otherwise indicated on the drawings or in the specifications.

3.4 DUCTWORK

A. Where ductwork is exposed to view provide factory-fabricated hangers that minimize the exposure of the supports.

B. Factory-fabricated, double-wall ductwork shall include factory hanger/supports systems provided by the duct manufacturer.

3.5 POWDER (GUNPOWDER) ACTUATED FASTENERS

A. Not allowed.

3.6 STEEL DECKING

A. On projects where floor or roof slabs are installed over steel decking, drill or punch web of steel decking and insert hangers with washers before the concrete fill is poured in place. Hangers shall be plumb within one-half inch (1/2") in four feet (4') and spaced as required for service intended.

END OF SECTION 23 05 29

SECTION 23 05 35
ELECTRIC MOTORS, HIGH EFFICIENCY TYPE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. This Section describes electric motors which are more efficient and have a generally better power factor than standard horizontal drip proof electric motors. These motors require less energy than standard electric motors which do not meet this specification.

B. This specification covers horizontal, 3 phase, integral horsepower, drip proof, squirrel cage induction motors in the NEMA frame sizes through 449.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division-23 and to all other applicable portions of the Drawings and Specifications.

1.4 STANDARDS

A. All motors shall be in accordance with NEMA Standard MG1-1978, or the latest revision insofar as it is applicable. Motors shall also comply with the applicable portions of the National Electric Code.

PART 2 - PRODUCTS

2.1 VOLTAGE FREQUENCY

A. Motors through 100 hp shall be rated 230/460 volts with 200 or 575 volts as optional; motors above 100 hp shall be rated 460 volts with 575 volts as optional. Motors will be rated for operation on a 3 phase, 60 Hertz power supply. Refer to Electrical Drawings.

2.2 COORDINATION

A. Where variable frequency drives are used to vary the speed and power consumption of electric motors, such motors must be high efficiency type and must be considered with the actual variable frequency drives which are provided so that optimum matching of variable frequency drive to driven motor is obtained.

2.3 OPERATING CHARACTERISTICS

A. Torques: Motors shall meet or exceed the locked rotor (starting) and minimum breakdown torques specified in NEMA standards for Design B for the ratings specified.

B. Currents: Locked rotor (starting) currents shall not exceed NEMA Design B maximum values for the specified rating. Motors shall be capable of a 20 second stall at six times full load current without injurious heating to the motor components.

C. Efficiency: Motors shall have a minimum and nominal full load efficiency which will meet or exceed the accepted values for industry standards for high efficiency motors when tested in accordance with NEMA test standard MG1-12.53a, IEEE Test Procedure 112, Method B, using accuracy improvement by segregated loss determination including stray load loss measurements. The minimum efficiency shall be guaranteed.

D. Power Factor: The power factor for 3600 and 1800 rpm, 3 through 250 hp ratings at full load, at full voltage, shall be a minimum of 85%. Six-pole ratings will be excluded from this requirement.

2.4 SERVICE FACTOR AND AMBIENT

A. Motors shall be rated for a 1.15 service factor in a 40^{o}C ambient.

2.5 INSULATION

A. Motors shall have a full Class B insulation system.

B. Motors shall be dipped and baked in polyester varnish to consolidate the winding.

2.6 FRAME SIZE

A. Horsepower/frame relationship shall conform to the latest NEMA Standard for T frame motors.

2.7 ENCLOSURE

A. Motors shall be drip proof construction.

B. Motor frame and end-shields shall be of cast aluminum construction using alloys with low copper content.

2.8 BEARINGS

A. All motors shall have anti-friction bearings, sized for a L-10 life of at least 125,000 hours L-10 life for a direct connected load.

B. Aluminum end-shields shall have a cast-in steel or cast iron bearing insert.

C. Bearing housing shall be re-greaseable with provisions for purging old grease.

D. Bearings shall be preloaded with a bearing loading spring to minimize noise and increase bearing life.

2.9 OTHER REQUIREMENTS

A. Conduit Box shall be diagonally split and rotatable in 90 degree increments.

B. External hardware shall be plated to resist corrosion.

C. External paint shall withstand industrial environments.

D. Nameplates shall be of stainless steel or aluminum and stamped per NEMA Standard MG1-10.37. Nameplate information shall include the nominal efficiency value per Standard MG1-12.53b and the manufacturer's minimum guaranteed efficiency value.

2.10 SHOP DRAWINGS

A. In addition to shop drawing requirements of the section entitled, "General Mechanical Provisions", provide motor data including horsepower; rpm; frame size; nominal efficiency and nominal power factor at full load, 75% load and 50% load; guaranteed efficiency and guaranteed power factor at full load, 75% load and 50% load.

PART 3 - EXECUTION

3.1 Section part not applicable.

END OF SECTION 23 05 35

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 05 48
VIBRATION ISOLATION EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Provide vibration isolation supports for all equipment and piping as may be required to prevent transmission of vibration to building structure. This shall include air handling units, fans, piping, and similar items.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division-23 and to all other applicable portions of the drawings and specifications.

1.4 SHOP DRAWINGS

A. Refer to Section entitled "General Mechanical Provisions". Submittal data shall show type, point loading information, size and deflection of each isolator proposed and any other information as may be required for the Architect/Engineer to check isolator selections for compliance with specifications. Include clearly outlined procedures for installing and adjusting the isolators.

1.5 MANUFACTURERS

A. Products of the following manufacturers will be acceptable, provided they comply with all of the requirements of this specification: Consolidated Kinetics; Mason Industries; Amber-Booth; Keflex; Flexonics; Vibration Eliminator Company or equivalent. Any model numbers listed are from one or more of these manufacturers and are given to provide an example of item(s) required.

1.6 OTHER REQUIREMENTS

A. All vibration isolation equipment shall be both recommended by the manufacturer and approved by the Architect/Engineer for each particular application on this project.

PART 2 - PRODUCTS

2.1 BASIC REQUIREMENTS

A. Unless otherwise noted, spring type vibration isolators shall be used for all motor driven equipment. It shall be the responsibility of isolation manufacturer to determine the amount of spring deflection required for each isolator to achieve optimum performance, prevent the transmission of objectionable vibration and meet noise criteria referenced herein.

2.2 CORROSION PROTECTION

A. Steel components shall be phosphated and painted. All nuts, bolts and washers shall be zinc-electroplated. Structural steel bases shall be thoroughly cleaned of welded slag and primed with zinc-chromate or metal etching primer.

B. All isolators exposed to weather shall have steel parts PVC coated or hot-dip galvanized. Aluminum components shall be etched and painted. Nuts, bolts and washers may be zinc-electroplated.

2.3 BASIC ISOLATORS

A. General: Unit designations indicated are Architect/Engineer designations. Each of the following basic isolators may not be applicable to a specific installation application. See PART 3, "EXECUTION".

B. Spring Mounts, Open Type, Unrestrained (Unit SMOU): Free standing springs; laterally stable; minimum horizontal-to-vertical spring rate (Kx/Ky) of 1.0: 1/2-inch neoprene acoustical friction pads between bottom baseplate and the supporting surface; leveling bolts; provision for bolting the mount to the equipment (unless otherwise specified); spring diameters not less than 0.8 of the compressed height of the spring at rated load; springs shall have a minimum additional travel to full compression of 50% of the rated deflection; 1-inch minimum static deflection (unless otherwise specified); submittals shall include spring diameters, deflections, free spring heights, solid spring heights and operating heights. Be similar to Mason Type SLF; Korfund Series L; Amber-Booth Type SW.

C. Spring Mounts, Open Type, Restrained (Unit SMOR): Free standing springs; laterally stable; 1/2 inch neoprene acoustical friction pads between bottom baseplate and the supporting surface; leveling bolts; provision for bolting the mount to the equipment (unless otherwise specified); spring diameters not less than 0.8 of the compressed height of the spring at rated load; springs shall have a minimum additional travel to full compression of 50% of the rated deflection; 1-inch minimum static deflection (unless otherwise specified); restraint consisting of welded steel channel ends for outdoor installation and welded steel studs for indoor installation; restraint shall have restraining bolts connecting top plate and lower housing to limit vertical rise of isolated equipment when load is reduced; vertical clearance of 1/8 to 3/8 inch shall be maintained between spring top plate and housing (leveling bolts shall be adjusted to maintain this clearance). Submittal shall include spring diameters, deflections, free spring heights, solid spring heights and operating heights. Be similar to Mason Type SLR; Amber-Booth Type CT.

D. Spring Mounts, Housed, Unrestrained (Unit SMHU): Springs free standing within their housing; laterally stable; 1/2 inch neoprene acoustical friction pads between bottom baseplate and the supporting surface; leveling bolts; provision for bolting the mount to the equipment (unless otherwise specified); spring diameters not less than 0.8 of the compressed

height of the spring at rated load; springs shall have a minimum additional travel to full compression of 50% of the rated deflection; 1-inch minimum static deflection (unless otherwise specified); welded steel housing; vertical clearance of 1/8 to 3/8 inch shall be maintained between spring top plate and housing (leveling bolts shall be adjusted to maintain this clearance). Submittal shall include spring diameters, deflections, free spring heights, solid spring heights and operating heights. Be similar to Mason Type C.

E. Neoprene and Spring Hangers, Vertical Deflection (Unit NSHV): Steel housing for undampened support of the spring: Provisions for attachment of hanger rods; reinforced neoprene washer and grommet to break up metal to metal contact; free standing spring; 1 inch minimum static deflection (unless otherwise specified) spring diameters not less than 0.8 of the compressed height of the spring at rated load; springs shall have a minimum additional travel to full compression of 50% of the rated deflection. Submittals shall include spring diameters, solid spring heights, free spring heights, deflections, overall hanger dimensions and maximum hanger rod diameter which can be accommodated by the hanger. Be similar to Mason Type DNHS: Amber-Booth Type BSR.

F. Neoprene and Spring Hangers, Vertical and Angular Deflection (Unit NSHVA): Shall contain a laterally stable steel spring and 0.3" reflection neoprene or fiberglass element in series. A neoprene neck shall be provided where the hanger rod passes through the steel box supporting the isolator mount to prevent metal to metal contact. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Mason Type 30N.

G. Neoprene and Spring Hangers, Vertical Deflection, Position Type (Unit NSHVP): Steel housing for un-dampened support of the spring; provisions for attachment of hanger rods; reinforced neoprene washer and grommet to break up metal to metal contact; free standing spring; 1 inch minimum static deflection (unless otherwise specified); spring diameters not less than 0.8 of the compressed height of the spring at rated load; springs shall have a minimum additional travel to full compression of 50% of the rated deflection; be capable of holding the supported item at fixed elevation during installation with secondary adjustment to transfer the load to the spring while maintaining a fixed position; scale and pointer to indicate the deflection. Submittals shall include spring diameters, solid spring heights, free spring heights, deflections, overall hanger dimensions and maximum hanger rod diameter which can be accommodated by the hanger. Be similar to Mason Type PCDNHS: Amber-Booth Type PBS.

H. Neoprene and Spring Hangers, Vertical and Angular Deflection, Position Type (Unit NSHVAP): Shall contain a laterally stable steel spring and 0.3" deflection neoprene or fiberglass element in series. A neoprene neck shall be provided where the hanger rod passes through the steel box supporting the isolator mount to prevent metal to metal contact. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Be capable of holding the supported item at the fixed elevation during installation with secondary adjustment to transfer the load to the spring while maintaining a fixed position; scale and pointer to indicate the deflection; similar to Mason Type PC30N.

I. Neoprene-In-Shear Hangers (Unit NH): Steel housing for un-dampened support of the neoprene; provisions for attachment of hanger rods; neoprene-in-shear isolator; similar to Mason Type HD, Amber-Booth Type HRD.

J. Neoprene-In-Shear Mounts (Unit NM): Double deflection neoprene-in-shear mountings shall have a minimum static deflection of 0.35". All metal surfaces shall be neoprene-covered. The top and bottom surfaces shall be neoprene ribbed and bolt holes shall be provided in the

base. On equipment such as small vent sets and close coupled pumps, steel rails shall be used above the mountings to compensate for the overhang; steel rails shall be by same manufacturer as vibration isolators and equivalent to Mason Industries Type DNR. Mounts shall be Mason Industries Type ND, Consolidated Kinetics Type RD or Vibration Mounts and Controls Series RD.

K. Flexible Pipe Connectors: Same internal diameter as the pipe in which the connector is installed (not necessarily internal diameters of inlets or outlets of equipment).

1. Both recommended by the manufacturer and approved by the Architect/Engineer to be suitable for handling the conveyed fluid at all conditions (maximums and minimums of temperatures, pressures, velocities, etc.) encountered for each particular application.
2. Of proper design to absorb the combination of vibratory and/or expansion or contraction motions (lateral and/or axial and/or angular) encountered at each installation point (for example, do not use hose type where axial motion is encountered at the installation point unless so recommended by the manufacturer and approved by the Architect.
3. Stainless steel bellows type (Unit SSB): Heavy duty steel restraining rods and spacers; laminated steel bellows; steel flanges; permit axial, lateral and angular movement; rated to withstand 180^{o}F operating temperature and 150 psig working pressure for chilled water; 250^{o}F operating temperature and 150 psig working pressure for heating hot water; similar to Keflex Series 151 or 301.
4. Stainless steel hose type (Unit SSH): Rated to withstand 180^{o}F operating temperature and 150 psig working pressure; have flanges except 2-1/2 inch and smaller sizes may have screw type fittings installed with a union at one end or with screw-on flanges at both ends; net flexible lengths shall be at least 6 pipe diameters for pipe up to 5 inch ID and not less than 36 inches for pipe 6 inch ID and greater; corrugated bellows with stainless steel wire braid restraining sheath; similar to Flexonics Type RW, RF or Series 400, Mason Type BSS, Keflex Series SSH.

L. Neoprene Pads (Unit NP): Waffle or ribbed pattern neoprene pads shall be fabricated from 40-50 Durometer neoprene. Mason Type W.

PART 3 - EXECUTION

3.1 GENERAL

A. All isolators shall be installed in strict accordance with the manufacturer's instructions and shall be properly adjusted prior to requesting final inspection or the performance of any vibration testing specified.

B. Each item of equipment (machinery, piping, etc.) which is provided with vibration isolation equipment shall rest in its intended, proper operating position (i.e.; exactly level, etc.) after installation of vibration isolation equipment. Approval of such vibration isolation equipment by Architect/Engineer shall not relieve the Contractor of this responsibility.

C. Equipment which is specified to rest on concrete housekeeping pads shall have Unit NP pads unless otherwise indicated.

3.2 PIPING IN AIR HANDLING UNIT/EQUIPMENT ROOMS (M.E.R.'s)

A. General:

1. Isolators for equipment are described elsewhere in this specification; and it shall be the responsibility of the vibration isolation manufacturer to coordinate the selection of piping supports with equipment supports to provide for a carefully engineered system designed to accommodate expansion and contraction without creating excessive stress at any equipment connections or in any portion of the piping.
2. Hangers for horizontal piping shall be installed at regular intervals. Pipe risers shall be supported at the base of the riser. Submit hanger schedule.
3. The first three piping supports away from any given piece of vibrating equipment to which piping is connected shall be selected for an operating spring deflection not less than that specified for the equipment isolators. All other vibration isolation supports for horizontal piping shall have a minimum operating deflection of 3/4" with capability of 50% additional travel-to-solid. All supports for pipe risers shall have deflection capability at least four times the expansion or contraction to be accommodated.
4. Temporary anchors, where required, shall be installed to permit pre-adjustment of springs in risers. Pre-adjustment procedure, which is intended to control direction of pipe movement and final operating deflection of the springs, shall be detailed in submittal data.
5. Permanent limit stops shall be installed to prevent excessive vertical motion of risers in the event water is drained from system. Locations and other details of these limit stops shall be submitted to Engineer for acceptance.
6. Piping connected to vibration isolated equipment shall be installed so that it does not strain or force out of alignment vibration isolators supporting the basic equipment, nor shall pipes restrict such equipment from "floating" freely on its respective vibration isolation system.
7. Drain piping connected to vibrating equipment shall not physically contact any building construction or non-isolated systems or components.
8. Do not allow the weight of the pipe to be carried by walls through which the pipe passes.

B. Isolator Locations:

1. Ceiling hung piping to air handling units: Provide neoprene and spring hangers, vertical and angular deflection (Unit NSHVA) at the first three support points of pipe runs connected to the vibrating equipment or at all support points along the first 50 feet of pipe runs connected to the vibrating equipment, whichever length is greater, but not to exceed length of mechanical equipment room.
2. Floor supported piping to air handling units: Provide resilient support for floor supported piping same locations as specified above for ceiling hung piping. Provide open type unrestrained spring mounts (Unit SMOU) for first three support points; use neoprene-in-shear mounts (Unit NM) thereafter and both with supplemental supports as required by job conditions.
3. Acoustic Seals: Provide acoustic seals (Unit AS) at all wall, ceiling and floor openings through which pipe runs from equipment rooms into adjoining spaces.

3.3 PIPING IN MECHANICAL EQUIPMENT ROOMS

A. General: The requirements of the paragraph entitled "General", in the above article entitled "Piping in Air Handling Unit/Equipment Rooms" shall also apply. Also, the following is applicable:

1. In order to be certain that the piping weight is properly distributed and not distorting the machine flanges, the first four hangers from each machine connection shall be position hangers.

B. Type and Extent of Piping to Isolated:

1. All Chilled water piping connected to Air Handling units. Blower Coil units not included.

C. Basic Isolator Types:

1. Floor Supported Piping: Unit SMOU, SMOR or SMHU, as applicable.
2. Piping Suspended from Parking Garage Structure: Units NSHVA or NSHVAP, as applicable.
3. Static Deflection: As recommended by the vibration isolation manufacturer as dependent upon size, length and weight of applicable piping and its conveyed fluid.
4. Acoustic Seals: Provide acoustic seals (Unit AS) at all wall, ceiling/floor openings through which pipe runs into adjoining spaces.

3.4 AIR HANDLING UNITS, FACTORY-PACKAGED

A. Floor Mounted:

1. Spring mounted (Unit SMOU) with 1 inch minimum static deflection when AHU motor is 5 hp. or less; spring mounts with 2 inch minimum static deflection when AHU motor is 7-1/2 hp. or greater. Instead of bolting the units to the spring mounts, provide height saving brackets. If the AHU manufacturer includes internal isolators inside the equipment and does not recommend external isolation, external isolation is not required. Provide neoprene isolators (NP) under the AHU's and ERV's if units are internally isolated.
2. Flexible duct connections as specified in "Duct System Accessories" section.
3. Flexible pipe connectors (Unit SSB).
4. Steel equipment frame (Unit SEF) manufacturer's standard unit frame or base is not sufficiently stiff and rigid to permit point vibration isolation.
5. Mount equipment on reinforced concrete pads as specified in other sections.

B. Suspended from Building Structure:

1. Spring hangers (Unit NSHV) with 1-inch minimum static deflection when motor is 5-HP or less; spring hangers (Unit NSHV) with 2-inch minimum static deflection when motor is 7-1/2 HP or greater.
2. Flexible duct connectors as specified in Section entitled "Ductwork".

3.5 BLOWER COIL UNITS

A. Floor Mounted:

1. Neoprene Pads (Unit NP): Provide neoprene isolators under the Blower Coil Units if units are internally isolated.
2. Flexible duct connections as specified in "Duct System Accessories" section.
3. Flexible pipe connectors (Unit SSB).
4. Mount equipment on aluminum/steel channel, 4 inches in height.

3.6 FANS, IN-LINE CENTRIFUGAL LIGHT DUTY

A. Flexible duct connectors as specified in "Ductwork".

B. Neoprene-in-shear hangers (Unit NH).

3.7 VAV TERMINAL UNITS

A. Flexible duct connectors as specified in "Ductwork".

END OF SECTION 23 05 48

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 05 53
IDENTIFICATION OF PIPING SYSTEMS, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary conditions and Division-01 Specification sections, apply to work of this section.

B. Painting of all “Exposed” ductwork shall be coordinated with the painting specifications. The mechanical contractor shall clean all insulated and non-insulated exposed ductwork prior to the painting of ductwork. Colors to be selected by the Architect.

1.2 SCOPE

A. Provide complete identification of the mechanical systems including piping, valves and equipment as noted herein.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Divisions 21, 22 and 23 and to all other applicable portions of the Drawings and Specifications.

B. This section directly relates in particular to sections (which may or may not be included in this division) which describe the following:

1. Piping and the interconnected equipment and component items for the following systems:

   a. A/C Condensate.
   b. Domestic Cold, Hot and Hot Water Re-Circulating.
   c. Fire Protection/Sprinkler.
   d. Storm Drainage.
   e. Sanitary Waste and Vent Systems.
   f. Grease Waste and Vent Systems.
   g. Refrigerant-based Systems.
   h. Insulation.
   i. HVAC Control Systems.

1.4 APPLICABLE PIPING AND RELATED ITEMS

A. Piping and interconnected equipment and component items for the following systems shall be identified. Identification of the following systems shall not preclude the identification of other systems where identification of such other systems may be specified in other sections. Systems requiring identification as work of this section are:

1. A/C Condensate.
2. Domestic Cold, Hot and Hot Water Re-Circulating.
3. Fire Protection/Sprinkler.

4. Storm Drainage.
5. Sanitary Waste and Vent Systems.
6. Grease Waste and Vent Systems.
7. Refrigerant based systems.
8. HVAC Control Systems.

1.5 SHOP DRAWINGS

A. Refer to Section entitled "General Mechanical Provisions". Provide schedule of colors, lettering, tagging, handling and similar items to clearly identify proposed method of identification for *FIRE PROTECTION, PLUMBING AND MECHANICAL* systems.

B. Valve Schedules: Submit valve schedules for each related piping system.

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

D. Samples: For color, letter style, and graphic representation required for each identification material and device.

E. Valve numbering scheme.

F. Duct marker/identification labels and stencils.

1.6 DIMENSIONS

A. Pipe dimensions as used in this section refer to the total outside dimensions (diameters) of both the pipe and its insulation (if any).

PART 2 - PRODUCTS

2.1 GENERAL

A. Comply with ANSI A13. 1-1975, "Scheme for Identification of Piping Systems" and OSHA requirements, or as otherwise indicated.

B. Acceptable Manufacturers: W. H. Brady Co., 2223 West Camden Road, Milwaukee, WI 53201; Seton Name Plate Corporation, 592 Boulevard, New Haven, CT 06505, or equivalent.

2.2 MARKERS, BANDS, TAGS AND LABELS

A. Markers: Must have approved color coded background, proper color of legend in relation to background color, approved legend letter size, approved length and flow arrow indicator.

1. Pipes 3/4" through 5" O.D.: Seton "Setmark" Type SNA marker or equivalent.
2. Pipes 6" O.D. and Greater: Seton "Setmark" Type STR marker or equivalent.

B. Bands: Color coded in minimum widths of 2-1/4" for pipe through 12" O.D. and 4" for pipe 14" O.D. and greater. Brady B-500 Vinyl Cloth, B-350 PermaCode or B-946 Outdoor Film or equivalent as applicable.

C. Valve Tags: Each tag shall designate appropriate service and valve number. Be securely attached with meter seals with 4-ply 0.018 copper smooth wire, or brass "S" hooks, or brass jack chain in a manner to allow easy reading. Provide either of the following types:

1. Brass Type: Minimum 19 gauge polished brass; 1-1/2" min. diameter. Acceptable: Seton Style 250-BL or equivalent.
2. Aluminum Color Coded Type: Anodized aluminum; 2": min. diameter. Acceptable: Seton Style 2070 or equivalent.
3. Aluminum Alloy Type: 16 gauge sheet aluminum: depressed type letters filled with black enamel. Face and periphery of satin finish Alumilite, Alcoa 204A2 or equal, free from burns and scratches. Seton Type 4 or equivalent.
4. Fiber Glass Type: 1/16" thick glass fiber reinforced resin. 2" x 2" size of 2-1/2" x 9" size as necessary to identify item. Brady Series No. 2297 or equivalent.

D. Labels: Provide either of the following types:

1. Plastic Type: Outdoor grade acrylic plastic to withstand weather, abrasion, grease, acid, chemical and other corrosive conditions; 1/16" min. thickness. Sized 3/4 x 2-1/2, 1 x 2-1/2, 1 x 3 or 1-1/2 x 4 as necessary to identify item. Seton "Setonite" or equivalent.

E. Ductwork: All HVAC systems ductwork shall be provided with duct identification labels in color-coded labeling per Seton Code Self-Adhesive Duct Markers. System shall identify the equipment served (i.e. (EF-2) and the duct service (i.e. EXHAUST).

PART 3 - EXECUTION

3.1 GENERAL

A. Apply only after completion of insulation, painting and cleaning work so that final identification is not disfigured by such other work.

B. Coordinate with actual composition and operating temperatures of surface on which identification is to be placed so that proper permanent adhesion of markers and labels to surface is obtained.

C. Locate marking and banding where practical such that groups of pipe are identified at similar location for ease of visual tracking. For example, mark and band parallel runs of pipe which are side-by-side at the same general place.

D. Small pipes less than 3/4" diameter may be identified with tags similar to those specified for valves.

E. Adhere or affix all identification items permanently except where removal may be necessary for maintenance or service.

3.2 MARKERS AND BANDS

A. Provide on piping as follows:

1. Pipe Concealed in Inaccessible Locations (e.g., Chases, Underground): No identification required.

2. Pipe Concealed in Accessible Locations (e.g., Ceiling Plenums):

    a. Markers every 30 feet of pipe length. Bands every 15 feet of pipe length.

3. Pipe Exposed in Equipment Rooms:

    a. Markers every 15 feet of pipe length for pipe through 12 inches O.D. and every 30 feet for pipe 14 inches O.D. and greater.

4. Bands every 10' of pipe length for pipe through 12" O.D. and every 25' for pipe 14" O.D. and greater.
5. Exterior Pipe, Exposed: No identification required unless otherwise indicated.

3.3 VALVE TAGS

A. Valve tags shall be installed on the following items:

1. All motorized valves (except those valves associated with direct control of flow to air handling apparatus whereby the valve may be identified by reference to the item of equipment it serves).
2. All fire protection system valves located in mains and branches (except those valves in fire hose cabinets).
3. All manual valves which perform functions other than isolation of an equipment item for servicing. This includes, but is not limited to, valves in valve stations, remote locations where use is not evident due to proximity of equipment or other piping, and similar locations.
4. Small piping (other than domestic water) where markers are impractical.
5. Small but critical equipment items on which it is impractical to install labels.

3.4 VALVE TAG LISTS

A. Prior to substantial completion, provide a complete list of all valves having tags. Indicate the following on such list:

1. Valve size.
2. Valve location.
3. Valve type.
4. Service application.
5. Valve manufacturer and model number.
6. Pressure class and allowable working pressure.

3.5 LABELS

A. Provide labels of proper size on mechanical system equipment including but not limited to, pumps, fans, rooftop equipment, duct heaters, air handling equipment, control panels, terminal units, flow stations, reheat coils and similar items.

B. Labeling for all major equipment (AHU’s, Fans, etc.) shall include the designation of the equipment and the month/year of installation. Example: “AHU1-1/ 09-2016”.

C. VAV Terminal Units, Fire Damper Access, fans, etc. that is concealed above ceilings shall include a fixed label on the equipment AND shall include an acrylic label permanently fixed to

the ceiling grid directly below the VAV terminal, fan, damper, etc. to permit ease of identification for maintenance, etc. The grid label shall be sized to fit neatly on the grid Tee.

3.6 DUCT IDENTIFICATION DEVICES

A. Duct markers: Engraved, “color-coded” laminated plastic. Include directional arrow and duct service for each system (such as AHU-1-Supply, AHU-2 Return, EF-1 Exhaust, etc.). Include contact type, permanent adhesive. Prepare all surfaces prior to installing identification.

3.7 WARNING TAGS

A. Pre-printed or partially pre-printed, accident-prevention tags, of color-coded laminated plastic. Color shall be yellow with black lettering.

B. Nomenclature: Large-size primary caption such as DANGER, CAUTION, etc.

C. Mechanical Equipment Rooms: Provide ¾” elastomeric padding AND Yellow/Black warning tape on ductwork, piping and other items where headroom clearances are less than *seven feet* off the finished floor.

3.8 COLORS

A. Colors for piping systems, ductwork and equipment which are required to be *painted* shall be as follows for those systems which may be applicable to this project:

1. Domestic Cold Water: Medium green enamel with domestic cold water legend.
2. Domestic Hot Water and Domestic Hot Water Recirculation: White insulation with yellow tape or metal bands with domestic hot water (domestic hot water recirculation) legend.
3. Fire Protection Piping: Red with fire line legend.
4. Sprinkler Piping: Red with sprinkler legend.
5. Roof/Storm Drainage Piping: Light green with storm water legend.
6. Sanitary Sewer and Vent Piping: Brown with sanitary sewer (vent) legend.
7. Grease Waste and Vent Piping: Brown with sanitary sewer (vent) legend.
8. Electrical conduit (not specified as painted in other divisions of these specifications): Silver.
9. Supply Air Ducts: Green.
10. Outside Air Ducts: Blue.
11. Exhaust/Return Air: Brown.

B. Identification: Coordinate colors and finishes with pipe, duct and equipment identification.

END OF SECTION 23 05 53

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 05 93
PERFORMANCE VERIFICATION, PRELIMINARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Put all work in a state of readiness for final performance verification.

B. Final performance verification shall not begin until the systems are complete and operable in all respects and all related building systems are complete.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 23 and to all other applicable portions of the Drawings and Specifications.

B. Refer to the section which describes "Performance Verification, Final".

PART 2 - PRODUCTS

This section not applicable.

PART 3 - EXECUTION

3.1 WATER SYSTEMS

A. Prepare each water system for balancing in the following manner:

1. Verify all systems have been flushed and all pre-strainers have been removed and permanent strainers installed.
2. Open all valves to the full position, including coil stop valves; close bypass valves, and open return line balancing cocks.
3. Clean all strainers.
4. Examine fluid in each system to determine that it has been treated and is clean.
5. Check pumps for proper rotation.

B. Check expansion tanks for full capacity of water and the absence of air lock.

C. Check all air vents at high points of system for proper installation and free operation. Remove all air from circulating system.

1. Set all temperature controls for full heat or full cooling (as applicable) from all coils.
2. Check for proper operation of any automatic bypass valves.

3.2 AIR SYSTEMS

A. Prepare the air side for balancing in the following manner:

1. All fans, blowers, and air handling equipment shall be mechanically checked and available to operate under design conditions.
2. All splitters, volume dampers, fire dampers, and vanes shall be in their neutral positions.
3. All grilles, diffusers, and like items, shall be installed with dampers, vanes, and blades in their neutral positions.
4. All controls shall be mechanically checked and ready to operate under design code in an operable and non-overloading condition.

3.3 ADDITIONAL REQUIREMENTS

A. Complete Installation: The Contractor shall complete the equipment and system installation to the satisfaction of the Architect/Engineer (who will be the sole judge of its state of readiness) prior to advising, the writing, that final performance verification is ready to begin. The Contractor is hereby advised that the Certificate of Substantial Completion will not be issued prior to the completion of final performance verification work and that he should therefore, schedule all other work accordingly allowing no less than 60 days for completion of final performance verification.

B. Clean, Flush and Fill Systems: The Contractor shall include the cleaning, flushing, filling, and venting of all hydronic and steam systems; the setup, check-out, and startup of chemical treatment systems; and the setup, checkout and startup of all equipment as work to be complete prior to the start of final performance verification.

C. Correction of Defects: The Contractor shall promptly and properly correct all defects in workmanship, material, installation and equipment of which he is aware prior to requesting that final performance verification work begin. Once the final performance verification work has begun, the Contractor shall promptly correct all defects in workmanship, materials, installation, and equipment as they are called to his attention by Architect/Engineer.

D. Drive Changes: Changes in pulleys or belts required for correct final balance during testing shall be made at no additional cost.

E. Scheduling and Coordination: The Contractor shall be responsible for proper scheduling and coordination of work involved in preliminary performance verification. This shall include, but is not necessarily limited to the timely provision of: mechanics, tools, equipment, correction of defects, equipment manufacturer's representatives, test modules, and all other items which may be required.

F. Report: Submit a written report describing and certifying in detail all preliminary performance verification items and tasks that have been performed. Approval of this report by the Architect/Engineer will precede final performance verification.

END OF SECTION 23 05 93

SECTION 23 05 94
PERFORMANCE VERIFICATION, FINAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Provide the services of an independent test and balance agency to verify the performance of the complete heating, ventilating and air conditioning systems as described by Division 23. Performance verification shall be accomplished by established testing and balancing procedures as described in this section.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 23 and to all other applicable portions of the Drawings and Specifications.

1.4 TEST AND BALANCE AGENCY

A. Quality Assurance that T & B Agency is certified by to be either AABC or NEBB. Agency must have been in business a minimum of three years or show that T & B work has been performed on a minimum of ten projects similar in size. Documentation must be submitted to Architect and Engineer for approval prior to starting any T & B procedures.

1.5 CONTRACTUAL RELATIONSHIP

A. Performance verification shall be performed as a service of the T & B Agency directly to the Contractor with no other subcontractors as part of the agreement.

B. Performance verification is specified in this Division 23 only because it relates predominantly to Division 23 work. However, the inclusion in this Division 23 of this section covering performance verification shall not preclude the contractual agreement of the T & B Agency from contracting directly to the Contractor with no other subcontractors as part of such agreement.

1.6 AGENCY APPROVAL

A. Submit the name and qualifications of the proposed T & B Agency to the Architect/Engineer for approval within thirty (30) days of Notice to Proceed.

B. Include AABC National Project Certification Performance Guaranty.

1.7 WORK INCLUDED

A. The T & B Agency shall provide all labor, supervision, professional services, tools, test equipment and instruments (except as otherwise specified) to perform the following work and all other work of this section:

1. Review the automatic temperature control and air terminal unit specifications for their respective and combined effects on the testing and balancing procedures for the air and hydronic systems.
2. Where in the opinion of the T & B Agency conditions may exist in the system design or construction that may have the potential of adversely affecting system performance, then the T & B Agency shall identify the condition and submit in writing recommended correctives for consideration by the Architect/Engineer.
3. During construction, review those shop drawings which have relevance to performance verification to confirm that the required piping, ductwork and equipment, and their respective specialties and accessories such as gauges, valves, dampers, access doors, etc., are properly selected, sized and located to permit proper and complete testing and balancing to be accomplished.
4. T & B Agency will perform a minimum of three (but not less than once per month) field investigations while HVAC Systems and all subcomponents are being installed. Before any field investigations are performed by T & B Agency, they must notify the Architect/Engineer of date and time of field investigation. Upon completion of field investigation, a written report must be submitted to the Architect/Engineer.
5. Perform a complete air and hydronic test and balance of all heating, ventilating, air conditioning and exhaust air systems and all water systems shown and described on the Construction Documents and as further described herein.
6. Submit Equipment Test and Systems Balance Report.
7. Furnish specifications to Contractor for properly sized fixed sheaves on fan systems after proper RPM has been established.
8. T & B Agency must witness and certify all duct leakage test rates and pressure tests on any piping performed by Mechanical Contractor. All tests certified by T & B Agency must be recorded and submitted in writing to Architect/Engineer.
9. T & B Agency shall complete and certify the performance of all kitchen hood ventilation system components including duct velocities, hood performance, airflows, and interlocking equipment operations.
10. T & B Agency shall include all participation required in the LEED process that includes any required re-balancing of equipment, T & B report documentation, etc.

1.8 GUARANTY

A. Warranty: The T & B Agency must provide a “National Project Performance Guarantee” as prescribed by AABC or NEBB testing procedures and standards that state AABC or NEBB will assist in completing the requirements of the Contract Documents if the T & B Agency fails to comply with the Contract Documents.

B. Additional Tests: Within 60 days of completing any and all T & B “Total System Balance” work and additional testing, adjusting, and balancing is needed to verify report parameters are being maintained, any and all work will be done at the T & B Agency’s expense. Any test the T & B Agency is asked to perform will be submitted in writing to the Architect/Engineer.

C. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter load occupancy and outside air conditions, the T & B Agency must perform the following tests: summer occupancy and outside design load conditions; winter occupancy and outside design load conditions. Before the T & B Agency performs any opposed seasonal test, he must first notify the Architect/Engineer.in writing. Any

and all opposed season test performed by T & B Agency will be at their expense. Any and all opposed season test performed by the T & B Agency must be recorded and submitted to Architect/Engineer.

PART 2 - PRODUCTS

2.1 GENERAL

A. The tangible product of this section shall include the reports and documentation necessary to verify the systems' performance.

2.2 REPORT

A. The T & B Agency shall in the course of his work record the information herein specified. Recorded test data shall be at the final balanced condition for each system. Recorded data shall be arranged by system using the appropriate designation as established on the Construction Documents. Four (4) copies of the final report signed, bound and indexed shall be submitted to the Architect/Engineer for his approval or comments.

B. T & B Agency's testing, adjusting, and balancing report must be submitted on AABC or NEBB registered forms approved by Architect/Engineer. All report forms must be certified by T & B Agency's National Certification stamp. All Test, Adjust, and Balancing forms must be approved by Architect/Engineer before the commencement of any T & B work.

C. Where actual measurements recorded for the final balance show deviations of more than 10% from the design, the T & B Agency shall note same in the report and submit recommendations for corrective action to the Architect/Engineer for his consideration.

D. In those cases where recorded data can be reasonably interpreted to be inaccurate, inconsistent and/or erroneous, the Architect/Engineer may request additional testing and balancing. The T & B Agency shall at no additional cost perform such retesting and rebalancing as directed by and in the presence of the Architect/Engineer.

E. Where, in the opinion of the T & B Agency, there is excessive vibration, movement or noise from any piece of equipment, ductwork, pipes, etc., the T & B Agency shall note same in the report and submit recommendations for action to the Architect/Engineer.

F. The T & B Agency shall verify that each thermostat and the devices it is controlling, such as control valves, motorized dampers, VAV boxes, etc., operate in the exact sequence required.

G. Test Data: Include the following data in the Systems Test and Balance Report:

1. Motors:
   Manufacturer
   Model and serial number
   Rated amperage and voltage
   Rated horsepower
   Rated RPM
   Corrected full load amperage
   Measured amperage and voltage
   Calculated BHP
   Measured RPM
   Sheave size, type and manufacturer.

2. Fans:
   Manufacturer
   Model or Serial number, BI or Air Foil - number of blades
   Design CFM
   Rated CFM, Initial/Final measured CFM
   Rated RPM, measured RPM
   Measured pressures - Inlet and Outlet Static Pressure
   Pulley size, type and manufacturer
   Belt size and quantity
   Rated TSP
   Operating TSP & operating ESP (at discharge side of
   Supply Fan or suction side of Exhaust/Return Fan)
3. Air Systems (including inlets and outlets):
   Provide single line diagrammatic plan locating each air inlet and outlet and its reference number.
   Grille or diffuser reference number and manufacturer.
   Grille or diffuser location.
   Design velocity.
   Design CFM.
   Effective area factor and size.
   Measured velocity.
   Initial/Final Measured CFM
   Initial/Final Terminal Unit CFM

H. Other Report Requirements: Where any systems have equipment or components which are not covered by the above, then the Final Test and Balance Report shall include the following data as applicable to such equipment or systems to confirm actual operation:

1. All inlet and outlet areas.
2. All applicable duct, pipe and coil sizes.
3. Outside, inside, mixed and supply air conditions.
4. All fluid velocities, flow rates, temperatures and pressures at appropriate locations.
5. All speeds.
6. All voltage and ampere ranges.
7. Descriptions of each test method used.
8. All name plate data.
9. All VAV terminal data.

2.3 INSTRUMENTATION

A. All test and balance equipment and instruments to be furnished by the T & B Agency shall have been calibrated within six (6) months of use on this work. A list of equipment and instruments to be used shall be submitted to the Architect/Engineer prior to commencing test and balancing operations and shall include equipment and/or instruments, name, manufacturer, serial number and certification of last calibration date. Instruments without calibration adjustment capability shall be accompanied with manufacturer's certification of accuracy. Test and balance equipment and instruments furnished by the Contractor to the T & B Agency shall be accompanied with certification as required above. The T & B Agency shall be responsible for the protection from damage due to accident, abuse or misuse, all equipment and instruments provided by the Contractor, and shall return same in good working condition at the completion of the test and balance work to the Contractor. The T & B Agency shall repair at his expense to original condition and accuracy or replace with like equipment and instruments damaged in the work.

2.4 DIAGRAMS

A. Provide a schematic diagram (i.e., one-line) of duct system(s) tested. Indicate on the diagram the relative location of all air distribution devices, VAV boxes, heating/cooling coils, points of data measurements (i.e., pitot traverse, temperature, static pressure) fans, air handling units, and similar equipment included in the system. Diagram shall identify each component tested. Said identification shall utilize the conventions shown on the drawings (i.e., AHU-1 or SF-6) and correlate with the data sheets provided in the Test and Balance Report.

2.5 LOGS AND FORMS

A. Logs and forms shall clearly indicate following:

1. All inlet and outlet areas.
2. All applicable duct, pipe and coil sizes.
3. Outside, inside, mixed and supply air conditions.
4. All fluid velocities, flow rates, temperatures and pressures at significant locations (e.g., fluid pressures before and after each pump and fan, temperatures and pressures at supply and return headers and at chiller and boiler inlets and outlets, etc.).
5. All fan speeds.
6. All motor ampere ranges.
7. Descriptions of each test method used.

PART 3 - EXECUTION

3.1 GENERAL

A. Sheaves: The Contractor shall provide applicable fans with V-belt drives and fixed pitch sheaves. In order to provide the properly sized fixed pitch sheave, the Contractor shall initially provide fans with V-belt drives, variable pitch sheaves. The Contractor, upon completion of system balancing by the T & B Agency, will replace these adjustable pitch sheaves with fixed sheaves of the size and type specified by the T & B Agency. The Contractor shall tag the adjustable sheaves, transmit same to Owner, and receive written receipt by Owner of acceptance of these sheaves.

B. Load Conditions: All testing and balancing of systems shall be undertaken with maximum attainable load. Testing and balancing of all air handling systems shall be accomplished with ceiling tile in place and enclosing partitions and doors erected.

C. Observe all equipment and exposed piping for noise, movement or vibrations under normal operating conditions and report excesses to the Architect and Owner.

D. Where patented measuring stations are installed, each of these is to be read and recorded. In the hydronic systems, the permanent devices, such as flow tubes with mercury manometers, annular ring systems, venturi tubes with portable meters, etc. must be used for final measurements after they are completed, calibrated and in satisfactory condition.

3.2 PERFORMANCE VERIFICATION, PRELIMINARY

A. Refer to specification section titled “Performance Verification, Preliminary”.

3.3 PROTECTION OF WORK

A. The Contractor shall protect all mechanical devices during the testing and balancing period. The activities of the T & B Agency will include but not be limited to the adjustments of designated balancing devices including; adjustment of balancing dampers, adjustment of inlet vane dampers, adjustment of air extractors, air splitters, or manual dampers, the adjustment of adjustable sheaves for fan speed, the adjustment of balancing valves, or similar devices. The existence of the T & B Agency shall not relieve the Contractor of his responsibility for the complete operation of the mechanical systems in conformance with the contract documents.

3.4 CORRECTION OF WORK

A. The Contractor shall at no additional cost to the Owner rectify discrepancies between the actual installation and contract documents when in the opinion of the T & B Agency the discrepancy will significantly affect system balance and performance.

3.5 COORDINATION AND ASSISTANCE

A. The Contractor shall assist the T & B Agency by providing all labor, equipment, tools and material required to operate all of the equipment and systems necessary for the testing and balancing of the systems and for the adjustment, calibration or repair of all electric or pneumatic or automated control devices and components. These services shall be available on each working day during the period of final testing and balancing. The Contractor shall assist the T & B Agency by arranging to have all ceilings, partitions, windows, and doors installed prior to the scheduled commencement of balancing within each specified area.

B. Coordination: The installing mechanical and controls contractor must provide an approved factory authorized service representative to assist and support the T & B Agency in the operation and testing of all HVAC Systems, Controls, and EMS Systems and all its subcomponents to ensure Total System Balance can be achieved without lengthy delays.

C. The Contractor shall provide to the approved T & B Agency a complete set of plans and specifications and an approved copy of all heating, ventilating and air conditioning equipment shop drawings. The Contractor shall include the cost of all pulley, belt, and drive changes, as well as balancing dampers required to achieve proper system balance recommended by the T & B Agency.

3.6 AIR SYSTEMS

A. The testing and balancing shall include, but is not limited to, the following requirements:

1. Adjust fan speeds to deliver the required cfm and static pressure, and record rpm and full load amperes.
2. T & B Agency will perform Pilot Tube Duct Traverses on all HVAC Air Moving Equipment to determine total air volume delivery and not static pressure. Once total air flow delivery is established off each piece of equipment, the T & B Agency shall make the necessary calculations so fixed drives can be installed in place of variable pitch drives. T & B Agency shall install fixed drives at no cost to the owner. Seal duct access holes with rubber or metal snap-in plugs.
3. Verify outside air flow for all conditions of systems with dual path air handling units and VAV systems.
4. Test and adjust each diffuser, grille and register to within 10% of design requirements, and also adjust so as to minimize drafts in all areas.

5. Observe all equipment and exposed ductwork for noise, movement or vibration under normal operating conditions and report excesses to the Architect/Engineer.

B. After all air distribution devices have been balanced to distribute calculated design indicated air quantities and if temperature in any area (where such area does not have the particular zone temperature control thermostat located therein) of any zone is not maintained within 2 degrees plus or minus of the zone areas which does have the zone temperature control thermostat, then notify Architect/Engineer of such conditions and obtain approval to rebalance devices to obtain air quantities other than those indicated so that air temperature in entire zone will be as even as possible regardless of calculated design air quantities. After obtaining approval to rebalance, perform such necessary rebalancing.

3.7 OTHER TESTING REQUIREMENTS

A. T & B Agency must record any and all HVAC System equipment name plate data, such as Air Moving Equipment, Cooling/Heating Coils (chilled water and electric), Variable Volume Air Terminal Boxes, Fan Powered Air Terminal Boxes, Exhaust, Supply, Return and Relief Fans, Water Pumps of various types, Chillers, and Cooling Towers and their subcomponents as set fort in AABC and NEBB national standards and testing procedures.

B. T & B Agency must test all HVAC System cooling and heating coils. T & B Agency must record both dry bulb and wet bulb on/off any cooling coils, energy recovery coils, energy recovery wheels, heat wheels, and heat exchangers. T & B Agency must record dry bulb temperatures on/off and electrical heating coils. T & B Agency must record chilled/hot water temperatures on/off coils. T & B Agency must calculate performance total BTU and tonnage off all cooling/heating coils, energy recovery coils, energy recovery wheels, and heat wheels.

C. T & B Agency will measure and record all electrical performance data on all HVAC Equipment and subcomponents on appropriate T & B forms approved by Architect/Engineer.

D. T & B Agency will verify and record all automatic control devices are functioning properly. Automatic control devices to include, but not limited to, supply, return, outside air, fire/smoke, volume, relief dampers, and etc.

E. T & B Agency will perform and record sound and vibration measurements on any HVAC equipment and subcomponents directed by the Architect/Engineer. All sound and vibration measurements must be recorded on appropriate T & B sound/vibration forms approved by Architect/Engineer.

END OF SECTION 23 05 94

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 07 00
INSULATION, HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Provide all work necessary to insulate all equipment, piping, ducts and other items related to the piping and duct systems.

1.3 RELATION TO OTHER WORK

A. Refer to the section, General Mechanical Provisions", for related requirements. Refer to other sections of Division-23 and to all other applicable portions of the Drawings and Specifications.

B. This section directly relates in particular to sections (which may or may not be included in this division) which describe the following:

1. Piping systems.
2. Duct systems.
3. Heat generating equipment.
4. Cooling equipment.

C. Vessels, tanks, stacks, and other items which contain or convey fluids which are at such temperatures as to create condensation or surface temperatures which are hazardous or where heat loss or gain prohibits proper system operation.

1.4 SHOP DRAWINGS

A. General: Refer to the Section entitled "General Mechanical Provisions". Shop drawings shall contain complete descriptive and engineering data, including flame spread and smoke developed ratings (ASTM E84 test method) on all materials and adhesives. Where finishes, covers, or jackets are specified, provide complete data on same. Shop drawings shall contain specified information on: densities, conductivities, conductances, or resistances as required to establish conformance with the specified values or materials.

B. Industry Standards: Where compliance with an industry, society or association standard is specified or indicated, certification of such compliance shall be submitted with shop drawings.

C. Commencement of Work: Submit shop drawings before any work is commenced.

1.5 STORAGE OF MATERIALS

A. Do not store fiberglass insulation within the building until it has been "dried in". If no other dry space is available and this insulation must be installed or stored before the building is "dried in" and completely enclosed, provide polyethylene film cover for protection.

1.6 COMPLIANCE WITH CODES AND STANDARDS

A. Applicable Codes: The total insulation system including insulation, sealant, finishes, etc., shall comply with or exceed all code requirements.

B. NFPA: All materials and adhesives used shall conform to the requirements of NFPA 90A as to flame spread and smoke developed ratings.

1.7 DEFINITIONS AND TERMINOLOGY

A. Terminology: Throughout this section, insulation products may be described as regards the location, surface or other point at which they are to be applied. Except in special cases (where a detailed indication or description will be given), the majority of conditions can be defined in whole or in part by use of (but not necessarily limited to) any or all of the following words:

1. "Internal" or "External".
2. "Interior" or "Exterior".
3. "Concealed" or "Exposed".
4. "Protected" or "Unprotected".

B. Definitions: Wordage used to describe locations, surfaces or other points or conditions shall be defined as follows as related to this section. Where the ascertainment or determination of locations, surfaces and other conditions is obvious from the intent of use of the item (e.g., roof-mounted ductwork, underground piping, etc.) or from other information, then the following words may not be required. If any ambiguity should occur, provide bid based on the most severe condition; however, obtain clarification from Architect/Engineer prior to installation:

1. "Internal" and "External": Relates to an item or its surface which is to be insulated or un-insulated. Does not relate to the confines of the building, structure or other entity in which the item is located. (Examples: internal/external surfaces of ductwork, pipe, air handling units or other such items.)
2. "Interior": Relates to the location of an item as to whether the item is within a heated, ventilated, air conditioned or otherwise controlled environment of the building, structure or other entity in which the item is located. "Interior" is always "Protected". (Examples(s): Interior ductwork, interior piping, interior air handling units.)
3. "Exterior": Relates to the location of an item as to whether the item is outside (i.e., exterior to) a heated, ventilated, air conditioned or otherwise controlled environment of the building, structure, facility or other entity which the item serves or relates. "Exterior" generally means that the item is surrounded by the ambient outside environment. "Exterior" is considered "Unprotected" unless otherwise described. (Examples(s): exterior rooftop air handling units, exterior ductwork, exterior cooling tower.)
4. "Concealed" and "Exposed": Relates to the visibility of an item. "Concealed" implies out-of-sight from normal view by an occupant, user or employee of the facility when such person is performing their normal function. "Exposed" implies that the item is readily visible by such a person when that person is performing a normal function. (Examples(s): "Concealed interior ductwork" would be out-of-sight in a ceiling plenum, whereas "exposed interior ductwork" would be readily visible in a mechanical equipment room or in a room which intentionally had no ceiling system.)

5. "Protected" and "Unprotected": Relates to an exterior item which may or may not be sheltered from the outside elements but which exists in contiguous contact with the ambient environment without benefit of any direct heating, ventilating or air conditioning. (Example(s): Piping or ducts located in an open crawl space beneath a building would be "protected/concealed"; in an open parking garage such piping or ducts would be "protected/exposed". Piping or ducts on a rooftop would be "unprotected" and usually "exposed".)

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials: Materials listed are those used as basis of design; equivalent products of acceptable manufacturers will be accepted. Materials must be approved and recommended by the insulation product manufacturer for the particular application(s).

B. Flame and Smoke Ratings: Application of insulation materials may require, in many cases, that the final insulation system comply with NFPA 90A with regard to maintaining a flame spread rating of 25 or less and a smoke developed/fuel contributed valve of 50 or less. In such cases, verify that the materials comply with the indicated flame spread and smoke developed ratings.

C. Applicability: Products and manufacturers listed may not all be applicable. Use only those products and manufacturers which are indicated as being applicable to a specific insulation condition.

D. Acceptable Manufacturers: Manufacturers which are listed are those manufacturers who may make one or more of the insulation products required. Listing of a manufacturer does not necessarily mean the manufacturer is approved for all applicable insulation conditions. Each listed manufacturer must still comply with the specific requirements of each insulation condition to be acceptable for the particular application. Acceptable manufacturers of insulation-related products include (but are not necessarily limited to) the following: Armstrong; CertainTeed; Knauf; Manville; Owens-Corning; Pittsburg Corning; Rubatex; Dow Corning Corporation; Duro Dyne Corporation; 3M Co.; United McGill Corporation

2.2 BASIC MATERIALS

A. Elastomeric Insulation: Preformed (tube), roll or sheet as indicated or as applicable. Nitrile, rubber based, closed cell structure. K factor of 0.28 at 75^{o}F. In tube, roll or sheet form of 3/4-inch thickness or less, ASTM E 84 flame spread rating of "25" or less and smoke developed rating of "50" or less. Recommended temperature applications from -40^{o}F to 220^{o}F when installed in accord with manufacturer's recommendations. Do not install in return air plenums unless flame spread rating and smoke developed rating are within constraints of applicable codes. Manufacturers and/or series: Armstrong "Armaflex"; Manville "Aerotube"; "Rubatex"; Gustin-Bacon "Ultra-Foam".

B. Fiberglass Insulation: Inorganic fibrous glass. Flame spread of "25" or less and smoke developed rating of "50" or less per ASTM E 84.

1. Board: Rigid or semi-rigid form, with foil-faced vapor barrier. Stiffness of 475 EI, 800 EI or 1400 EI as indicated.
2. Blanket: Flexible form; with foil-faced vapor barrier.
3. Preformed: Jacketed or unjacketed as indicated.

2.3 INSULATION PRODUCTS, BASIC

A. Type PI-1: Pipe insulation, preformed cellular glass. Pittsburg-Corning "Foamglas" or equivalent.

B. Type PI-2: Pipe insulation, preformed jacketed fiberglass. Jacketed with factory-applied kraft reinforced foil vapor barrier jacket. Jacket closure system of double pressure-sensitive adhesive on longitudinal joints; self-sealing butt strips at circumferential joints; provide positive vapor barrier seal. Thermal conductivity (K) of 0.24 at 100°F. Owens-Corning Fiberglas ASJ/SSL-II; Manville Micro-Lok with AP-T Plus jacket; CertainTeed 500 Snap-On; or equivalent.

C. Type PI-5: Pipe insulation, preformed elastomeric. Rubatex, Armaflex II or equivalent.

D. Type I-1: Cellular glass block insulation. Field formed, fitted and finished as required for the application. Pittsburg-Corning Foamglas or equivalent.

E. Type I-3: Elastomeric insulation. Field formed, fitted and finished as required for the application. Armaflex, Rubatex or equivalent.

F. Type DI-1: Duct insulation, fiberglass flexible blanket wrap. Composed of flexible blanket of glass fiber factory laminated to a reinforced foil kraft (FRK) vapor barrier with a minimum 2-inch taping and stapling flange on one edge. Suitable for operation at temperatures from 40°F to 250°F. Thermal conductivity of 0.31 at 75°F. Minimum density of three-quarter (3/4) pound per cubic foot. Provide in thickness of (2.2) inches unless otherwise specified as 2-1/2 or 3-inch thickness. Owens-Corning All Service Faced Duct Wrap; Manville R-Series Microlite; CertainTeed Standard Duct Wrap; or equivalent.

G. Type DI-2: Duct insulation, fiberglass semi-rigid board. Composed of resin bonded glass fibers faced with a foil scrim-kraft (FSK) reinforced laminate of aluminum foil and kraft bonded to provide a metallic surface finish vapor barrier; alternate vapor barrier facing (if specifically indicated) is an all service jacket (ASJ) of high intensity white bleached, chemically treated kraft paper reinforced with fiberglass yarn mesh and laminated to aluminum foil with fire-retardant adhesive to impart a clean, white appearance. Conductivity (K) of not greater than 0.23 at 75°F. Provide in thickness of one (1) inch unless otherwise indicated. Provide with minimum density of 3-pcf unless 6-pcf is specifically indicated. CertainTeed Industrial Insulation Board Type IB-300 (or IB-600); Manville 800 Series Spin-Glas Type 814 (or 817); Owens-Corning 700 Series Industrial Insulation Board Type 703 (or Type 705); or equivalent.

2.4 INSULATION ADHESIVES, MASTICS, SEALANTS

A. Adhesive (Type A-E1): For joints and seams in elastomeric insulation (Type I-3) not requiring weather protection. Rubatex R-373 Insulation Adhesive; Armstrong 520 Adhesive or equivalent.

B. Joint Sealant (Type JS-CG1): Non-hardening vapor barrier sealant specifically designed for use with cellular glass insulation (Types PI-1, I-1): Foster's 35-40 Foamseal Sealant, Pittsburg-Corning Pittseal 111 Sealant or equivalent.

C. Adhesive (Type A-F1): For adhering fiberglass blanket and board insulations (Types DI-1, DI-2) to metal substrate such as ductwork. Insulcoustic I-C 201, Foster 85-20 or equivalent.

D. Mastic, General Purpose (Type M-GP1): Non hardening vapor barrier general purpose mastic. For use where indicated or otherwise applicable. Foster GPM 35-00 or equivalent.

2.5 INSULATION FINISHES, JACKETS AND COVERS

A. Finishing Coating (Type FC-E1): For weather protection of elastomeric insulations (Types I-3, PI-5). Rubatex 374 coating; Armstrong Armaflex Finish or equivalent.

B. Finish Fabric, General Purpose (Type FF-GP1): Nylon membrane. For use generally with fiberglass duct insulations (Types DI-1, DI-2) at joints or seams or as may be indicated. Apply using Foster GPM 35-00 or equivalent.

C. Jacket, Pipe, PVC (Type JP-PVC): All purpose, UL-rated, white vinyl jacket, with or without self-sealing feature. Pittsburg-Corning "UNI-JAC" or equivalent.

D. Jacket, Pipe, Aluminum (Type JP-A1): Aluminum jacketing, 0.025 inches thick, type 3003 alloy, H-14 temper, circumferentially corrugated, with a continuously laminated moisture barrier of one mil polyethylene film and a protective layer of 40 lb. virgin kraft paper. Childers Products Co. "Corolon"; General Aluminum Supply Co. (Gasco); Insulcoustic "Alcorjac" or equivalent.

E. Pipe Fitting Covers, PVC (Type PFC-PVC): Insulated polyvinyl-chloride fitting covers in shapes as required; with fiberglass insulation insert. Suitable for temperature range of 0°F to 450°F. Flame spread rating of 25 or less and smoke developed rating of 50 or less when kept below 150°F. Acid, alkali and chemical resistant. Suitable for painting if required. Manville Zeston 25/50 PVC Insulated Fitting Covers or equivalent.

F. Pipe Fitting Covers, Aluminum (Type PFC-A1): Aluminum fitting covers, 0.025 inches minimum thickness, type 3003 alloy, H-14 temper prefabricated fitting covers with baked epoxy moisture barrier for pipe sizes through 24". Field fabricate fitting covers for pipe sizes larger than 24" using 0.025 inches thick aluminum roll jacketing with laminated polyethylene/kraft moisture barrier. Childers Products "Ell-Jacs", "Gore Ell-Jacs", "Tee-Jack", "End-Caps", and "Flange Jacs" or equivalent.

2.6 RELATED PRODUCTS

A. Wire (Type W-1): Dead soft, 16-gauge, stainless steel.

B. Straps (Type ST-1): Stainless steel T-304 (18-8) soft annealed with deburred edge with stainless steel wing seals. Childers Products "Febstraps" or equivalent.

C. Tape (Type T-1): High tensile strength rope stock flat back paper pressure sensitive tape. Pittsburg-Corning "PC Tape No. 25" or equivalent.

D. Screws (Type S-1): Aluminum pan head type "A" slotted #8 by 1/2-inch.

PART 3 - EXECUTION

3.1 GENERAL

A. Field Forming, Fitting and Finishing: Where preformed insulation products are indicated as being acceptable for a particular application, provide field formed, fitted and finished insulation systems if such application is more practical (such as due to size, configuration or dimensions which may be outside of the availability ranges for size, dimension and/or thickness of preformed products).

B. Pre-installation:

1. Do not apply insulation adhesives, materials or finishes until the item to be insulated has been completely installed and tested and proved tight and suitable for insulation.
2. Prepare surfaces to be clean and dry before attempting to apply insulation.

C. Insulation Shields: Provide hanger or pipe support shields of 16 gage (minimum) galvanized steel over or embedded in the insulation. Shield shall extend halfway up the pipe insulation cover and at least 6" on each side of the hanger. Securely fasten shield with pipe straps at each end.

D. Valves, Cocks and Specialties: Insulate as for the related piping system in which they are located unless otherwise indicated.

E. Factory Pre-insulated Components: Where equipment and other system components are specified in other sections to have factory installed insulation, then no additional insulation is required as work of this section unless additional non-factory-installed insulation is specifically described. Examples of such equipment and components which may not require additional insulation include, but are not necessarily limited to, boiler vessels, chiller evaporators, air handling units, airside terminal units, and similar items.

F. Minimum Thicknesses: Insulation thicknesses which are indicated are minimum thicknesses. Contractor may provide the same insulation material in greater thickness as an aid to installation and handling procedures or due to material availability and procurement considerations.

G. Branch Run-outs: Branch run-outs are considered to be individual supply/return pipes to individual terminal heating or cooling units (duct mounted coils, airside terminal units with heating coils, fan coil units, humidifiers, and similar small equipment). The supply/return pipe to such units is not considered to be a branch run-out if the length of the supply or return pipe exceeds 12'-0" in length to the coil/unit connection.

H. Insulation for Plumbing Systems: See other sections describing insulation for plumbing systems.

3.2 INSULATION THICKNESS FOR PIPING SYSTEMS

A. General:

1. Basis: Insulation thicknesses for piping are given for insulation installed in the locations indicated. Thicknesses are based on the various conditions of temperature, usage and environment which are typically encountered.
2. Applicable Thicknesses: All thicknesses as applicable to all conditions may not be given in this section article. Where an insulation thickness for a particular application is specified to be of other thickness than may be listed in this section article, "INSULATION THICKNESSES FOR PIPING SYSTEMS", then provide the insulation in the thickness indicated in other portion of this section which specifically describes the particular insulation application and its required insulation thickness. Thicknesses for other than piping insulation are given in the specific description of the particular application or description of the particular material used.
3. Ambient Conditions: Unless otherwise indicated, ambient conditions for the purpose of describing insulation thicknesses are related to cold applications to prevent condensation or excessive heat gain (e.g., chilled water pipe, cold vessels) and are related to hot applications to prevent harm to personnel or to prevent objectionable heat loss to the environment (e.g., hot water pipe, hot vessels, hot stacks).

a. These conditions are generally:

Interior: 80ºF and 80% RH.
Exterior: 90ºF and 80% RH.

4. Thickness Requirements: Thicknesses are given below based on the following information:

a. General type of fluid or process involved (e.g., chilled water, hot water, refrigerant).
b. General location and, if necessary, conditions related to temperature (either or both internal or external to the insulation barrier) and ambient environment of the insulated item.
c. Pipe size range.

3.3 REFRIGERANT SUCTION PIPING

A. Interior, Concealed (e.g., ceiling plenums): Insulate with prefabricated, elastomeric pipe insulation, 1” thickness.

B. Exterior: Insulate with prefabricated, elastomeric pipe insulation, 1” thickness AND provide pre-fabricated aluminum jacketing and fittings with stainless steel bands, etc. Protective UV inhibitor paint coatings over insulation will not be accepted as a substitute to the jacketing requirements.

3.4 DUCT SYSTEMS

A. General:

1. Locations and extent of both internal and external insulation for duct systems are described in section entitled "Ductwork" and/or by the "Duct Type and Location Schedule" on the Drawings.
2. Internal Insulation: Ductwork which is required to be insulated internally (acoustically/thermally lined) shall be insulated as work of the section entitled "Ductwork".
3. External Insulation: Ductwork which is required to be insulated externally shall be insulated as work of this section.
4. Factory Insulation: Ductwork which is factory manufactured with internal or external insulation is not to be additionally insulated as work of this section unless specifically stated. Such factory insulated ductwork generally consists of flexible externally insulated ductwork and double walled acoustically thermally lined ductwork.

B. Interior, Concealed (e.g., ceiling plenums): Where external insulation is required, insulate externally with 2.2 inch thick fiberglass blanket wrap (Type DI-1). Adhere duct insulation using adhesive (Type A-F1) applied in accordance with the manufacturer's recommendations. Where duct width exceeds twenty-four inches (24"), the insulation shall be additionally secured to the bottom of the duct using mechanical fasteners spaced one foot (1') on center. Insulation shall be applied with edges tightly butted, and all joints and breaks in the vapor barrier sealed using glass fabric and mastic applied in conformance with manufacturer's recommendations.

C. Interior, Exposed, (e.g., air handling unit rooms, ductwork exposed in occupied areas, etc.): Where external insulation is required, insulate with 1-inch thick semi-rigid fiberglass board (Type DI-2). Adhere to ductwork with adhesive (Type A-F1). Finish joints and seams with finish fabric (Type FF-GP1). Duct taping of joints is not permitted. Coordinate clean finish on the exposed ductwork. *Foil duct tape is not acceptable and all joints must be taped and mastic*

coated with a neat finish. The insulation contractor shall prepare a 4 foot mock-up sample for review and approval.

3.5 DUCT SYSTEMS EQUIPMENT

A. General: Insulate all supply, return, unconditioned and tempered/conditioned outside air intake/supply ductwork and plenums.

B. Fire Damper External Surfaces:

1. Externally Insulated Duct Locations: Extend duct insulation up face of fire damper to damper sleeve. Seal insulation edges with 4-inch minimum width duct tape.
2. Internally Insulated Duct Locations: Provide additional external insulation from a point on the duct 12 inches from the fire damper to the fire damper and on the face of the fire damper to the fire damper sleeve. Seal insulation edges with 4-inch minimum width duct tape.

C. Air Distribution Devices: Insulate the backs of all ceiling diffusers and other air outlet devices installed in other than return air plenums as specified for interior concealed ducts.

D. Dryer Exhaust Ductwork: Insulate with flexible fiberglass duct insulation.

3.6 COLD EQUIPMENT AND RELATED COMPONENTS

A. Condensate Drain Piping from Cooling Coils and Food Service Equipment:

1. Interior, Protected: Insulate with preformed elastomeric pipe insulation (Type PI-5) secured with adhesive (Type A-E1) and finished with white finish coating (FCC-E1). Thickness 3/4-inch. Provide 25/50 flame/smoke rating.

B. Flexible Pipe Connectors for Vibration Isolation: Insulate with elastomeric insulation (Type 1-3). Secure the insulation with adhesive (Type A-E1) applied to a clean surface and finish with white finish coating (FC-E1). Insulation thickness shall be one and one-half inches (1-1/2").

END OF SECTION 23 07 00

SECTION 23 09 23
DIRECT DIGITAL CONTROL SYSTEMS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

A. Basic Requirements: Provisions of Section 23 01 00, BASIC MECHANICAL REQUIREMENTS.

1.1 SUMMARY

A. Furnish all labor, materials, equipment, and service necessary for installing a building-wide DDC temperature control system, as defined by ANSI/ASHRAE Standard 135B2001.Direct Digital Controls, electronic interfaces and actuation devices, as shown on the drawings and as described herein.

B. The control system shall use an open architecture.

1. Native BACnet as the common communication protocol between all controllers and integral ANSI / ASHRAE™ Standard 135B2001.

C. The System shall provide a Web-Based Graphical User interface where the owner may make all adjustments, settings, and changes through the same software during any single session without having to launch an additional piece of software.

D. Ceiling tiles damaged during the construction due to control work shall be replaced at no additional cost to the Owner.

E. Contractor shall seal all penetrations with fire rated sealant.

1.2 INSTALLATION

A. All work described in this section shall be installed, wired, circuit tested and calibrated by trained electricians and mechanics qualified for this work and in the regular employment of the control contractor.

B. The installing office shall have a minimum of five years of experience in the installation of Web-Based DDC temperature control systems. The installation work shall not be subcontracted.

C. The temperature control contractor's office and base of operation where at least five employees report to work shall be within a 75-mile radius of the job site. During the warranty - period the contractor shall respond be able to warranty calls within 6 hours.

D. All control valves, damper motors, thermostats, sensors, air flow switches, transformers, transmitters, transducers, controllers, panels & enclosures, or any type of control component shall be appropriately selected, matched and engineered to provide a seamless and functional system.

E. All temperature control and interlock wiring shall be installed in conduit in exposed areas, mechanical rooms, wall cavities and in ceiling return air plenums. Where concealed or allowed

by Division 26 PVC jacketed cable may be used in concealed areas as long as bundles are neatly strapped and supported every three feet.

F. The control contractor shall provide all VAV controllers to the terminal unit manufacturer. Provide inlet sensor.

G. All power wiring for control panels or any control device requiring 120-VAC shall be provided by Division 26. The control contractor shall be responsible for contracting independently with the general building's electrical contractor for providing all power requirements for additional control equipment.

H. Tags, charts and Identification:

a. Tags: Tag Automatic Control valves, Dampers, VAV Terminals, Temperature sensors and all other controlled devices and controllers in accordance with Section 23 05 53 of the specifications.
b. Drawings: Provide laminated 11" X 17" as-built graphic diagrams of the systems and control sequences adjacent each system control panel.

1.3 SUBMITTALS

A. Drawings:

1. Furnish and provide 10 copies of a complete submittal composed of introduction, control drawings with sequences and specific information sheets showing pictures and engineering data of provided equipment.
2. Drawings shall be standard sizes 11" x 17". Drawings shall be computer generated with ACAD revision 2018 or higher.
3. The controls contractor shall also be responsible for providing a final, completely packaged control documentation submittal including all components, control drawings, sequences, etc. in a neatly indexed three-ring binder part of the close-out document submittal. The close-out documents shall include three copies of this Close-Out binder package for the Owner's record.

B. Drawings shall indicate:

1. Show footprint of the complex showing approximate equipment and node locations. When possible the footprint AutoCAD drawing files shall be available from the consultant.
2. LAN routing of cable or bus from node to node indicating data-line protection and building entry.
3. System architecture schematically shows the complete communication structure of the system.
4. Flow diagrams of each uniquely controlled system showing components and their relative placement and the path of piping or ductwork as it relates to the conditioning of its respective fluid.
5. Wiring schematics showing the controller terminals and all connected component terminals, showing point-to-point wiring.
6. Sequence of operation for each piece of system or subsystem describing the operation.
7. Provide manufacturer's instructions and drawings for installation, maintenance and operation of all purchased items.

C. Upon the completion of the project 5 copies of maintenance and operations manuals shall be produced with as-built control drawings, technical data, and maintenance and troubleshooting data as well as programming manual for all automation to be turned over to the owner.

1.4 ADDITIONAL REQUIREMENTS/RELATED WORK

A. Related Sections: Other Sections of Division 23, which relate to the requirements of this Section.

B. Related Divisions: Other Divisions of these specifications, which relate to the requirements of this Section, may include but are not limited to the following: Division 26, ELECTRICAL.

1.5 SYSTEM DESCRIPTION

A. General Requirements:

1. Provide a Global Controller and Graphical user interface to a file server connected to a network of programmable or stand-alone terminal unit controllers, with JAVA script generator and WEB-broadcast. System modifications must be capable of up to 10 simultaneous users in the base bid software and use all standard web-browser features.
2. All DDC Controllers for terminal units, air handlers, central mechanical equipment and Windows based operators' terminal(s) shall communicate with each other and share information.
3. Generate Graphic Screens for all mechanical equipment, floor plans, a main quick look screen detailing all equipment on one screen with status and area temperatures,
4. Use industry standard sensor and process signals. Normal 10K ohm, 1K ohm sensors shall be used. Provide standard 4-20mA or 2-10vdc control signals on all modulating devices. Provide standard sensors that can be obtained from more than 3 sources.
5. The project shall be inclusive of all costs. Systems that require the payment of any type of royalty fees will not be permitted or used. This shall also apply to replacement parts.
6. All scheduling, Alarming and Trending shall be an inherent part of the Automation Software, built by the manufacturer as an integral part of the Graphical User interface.
7. The Controllers and Software protocol shall both be recognized an ANSI standard.

B. Basic System Features:

1. Specified control of space temperature, usage scheduling, optimum starting, equipment failure reporting, and override timers for off-hours usage.
2. Graphic screens. Refresh rates of all screens regardless of the amount of information shall be within a maximum of 10 seconds.
3. Complete energy management firmware, including self-adjusting optimum start, demand limiting, and global control strategies and logging routines for use with total control systems.
4. Priority password security systems to prevent unauthorized use. Each user shall have an individual password. Each user shall be assigned which control functions they have access to.
5. Equipment monitoring and alarm function including information for diagnosing equipment problems.
6. The complete system including but not limited to terminal unit controllers, Global controllers and Operator terminals shall Auto-restart, without operator intervention, on resumption of power after a power failure.
7. Direct access to any point in the system from the global controller interface shall include all physical, Pseudo type, logical, or software points and values.
8. Each field panel capable of independent control and stand-alone operation.
9. Equipment runtime totalization of fans, heaters, etc., capable of alarm generation and alarm dial out to remote sites.
10. Room sensors with digital readout that allow the user to view room temperature, view outside air temperature, adjust the room set-point within preset limits and set desired

override time at each VAV box that allow local control and adjustment and VAV box setup and balancing.

11. All DDC hardware and software shall be designed and manufactured by U.S. corporations. All hardware shall be U.L. listed with integral labels showing rating.
12. Support fiber-optic LAN communications as well as hardwire.
13. Field Controllers shall be BACnet/MS/TP.
14. Both Ethernet Level and MS/TP level controllers shall be of the same protocol; BACnet.
15. Provide all necessary materials and labor required to interface with the lighting contactor's and provide any additional materials/labor to accomplish this control requirement.

1.6 QUALITY ASSURANCE

A. Responsibility: The supplier of the DDC shall be responsible for inspection and Quality Assurance for all materials and workmanship furnished by him.

B. Tools, Testing and Calibration Equipment: Provide all tools, testing and calibration equipment necessary to ensure reliability and accuracy of the DDC System.

1.7 REFERENCE STANDARDS

A. The latest edition of the following standards and codes in effect and amended as of date of Supplier's Proposal, and any subsections thereof as applicable, shall govern design and selection of equipment and material supplied:

1. ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
2. UBC Uniform Building Code, including local amendments
3. UL 916 Underwriters Laboratories Standard for Energy Management Equipment
4. NEC National Electrical Code

1.8 WARRANTY

A. Warranty shall cover all costs for parts, labor, and associated travel, and expenses for a period of TWO years from completion of system demonstration.

B. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the Vendor. The maximum acceptable response time to provide this service at the site shall be 4 hours.

C. This warranty shall apply equally to both hardware and software.

1.9 MATERIALS/ACCEPTABLE MANUFACTURERS

A. All materials and equipment used shall be standard components, of regular manufacture for this application. All systems and components shall have been thoroughly tested and proven in actual use.

1. Alerton.
2. Automated Logic.
3. Tekplan Solutions.

B. The above manufacturer applies to operator workstation software, controller software, the custom application programming language, Building Controllers, Custom Application Controllers, and Application Specific Controllers. All other products specified herein (e.g. sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturer.

C. The Contractor shall use only products from the corresponding manufacturer and the product line listed.

1.10 SOFTWARE LICENSE AGREEMENT

A. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

B. It is the owner's express goal to implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, EMS Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner.

PART 2 – CONTROL SYSTEM COMPONENTS

2.1 SYSTEM TERMINAL/ WINDOWS GUI

A. Installed DDC System Displays:

1. Graphic files shall be created utilizing scanned full color photographs of system installation, AutoCAD drawing files of field installation drawings and wiring diagrams from as-built drawings. System shall be capable of displaying graphic file, text and dynamic point data together on each display. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units.
2. All displays shall be generated and customized in such a manner by the local supplier that they fit the project as specified. Displays shall use Standard English for labeling and readout. Systems requiring factory programming for graphics or DDC logic are specifically prohibited.
3. Digital points shall be displayed as On/Off or with customized text.
4. Analog points shall be displayed with operator modifiable units.
5. Analog points may also be assigned to an area of a system graphic, where the color of the defined area would change based on the analog points value.
6. All dynamic point information shall be updated on the Operators terminal display CRT once every 1 second. Devices in the field shall act any changes by the operator on within 2 seconds maximum.
7. Displays may be modified via Web communications, over the District WAN and through the Internal Intranet as well.
8. Provide text graph screens showing sequences of operation for each piece of equipment.

9. Provide end switch feedback on all close-off dampers to allow fans to start.
10. Provide separate wiring/programming to facilitate scheduling of ventilation system-ERV's, EF's, OA Units, etc.
11. Programming, graphics, and databases associated with the system shall be generated and supported by local control system vendor.
12. Owner's Maintenance Department personnel shall be provided with all software, hardware (special cables or software "keys"), licenses, and training necessary to enable end user to modify any portion of the entire system. System capabilities include internal programming, screen graphics, adding and removing hardware such as controllers, sensors, workstations and network interfaces and training shall be accomplished prior to end of warranty period.

B. Security System:

1. Provide security system that prevents unauthorized use unless operator is logged on.
2. System shall maintain a log of all user activities while logged onto the system. Provide for easy viewing of all items in user log, including time and date of login, logoff and all activities in between.

C. Display of Scheduling Information:

1. Display of all schedules shall show all information in easy to read format for each schedule. This includes all on/off times for each day along with all optimum start information.
2. Holiday schedules shall show all dates that are to be holidays. Each day assigned as a holiday shall display as "All Off" or show the times scheduled for that day.
3. Event schedules shall be shown in the same graphical format. After event has elapsed, control returns to normal schedule.
4. Operator shall be able to change all information for a given Weekly, Holiday or Event schedule if logged on with the appropriate security access.

D. Alarm Indication and Trending:

1. System alarms may be directed to terminals, PDA's, Web Enabled phones, printers, digital or analog pagers.
2. Provide log of alarm messages. Alarm log shall be archived. Each entry shall include point descriptor and address, time and date of alarm occurrence, point value at time of alarm, time and date of point return to normal condition, time and date of alarm acknowledge.
3. Alarm messages shall be in plain English and shall be user definable on site or via remote communication. System shall provide a minimum of 20 user definable messages for each zone controlled.
4. System shall periodically gather samples of point data stored in the field equipment) and archive the information on the Operator terminals hard disk. Archive files shall be appended with new sample data, allowing samples to be accumulated over several years. Systems that write over archived data shall not be allowed. Samples may be viewed at the operator's terminal in a Trend Log. Trend log displays shall be in spreadsheet format.
5. System software shall be capable of graphing the trend log point data. Software shall be capable of creating graphs in the following forms as a minimum: Bar charts, Log/Linear graphs, Bubble graphs, x-y graphs, Log/Log graphs, Area graphs (2D or 3D), Pie charts, Scatter graphs, Polar graphs, High-Low-Close graphs.
6. Operator shall be able to change trend log setup information as well. This includes information to be trend logged as well as interval at which information is to be logged. All points in the system may be logged. All operations shall be password protected.

E. Energy Log Information:

1. System shall periodically gather energy log data stored in the field equipment and archive the information. Archive files shall be appended with the new data, allowing data to be

accumulated over several years. Systems that write over archived data shall not be allowed. Log data may be viewed in a spreadsheet format. Provide capability for operator to scroll through all Energy log data vertically (time axis) and horizontally (point sample columns). System shall automatically open archive files as needed to display archived data when operator scrolls through the data vertically. Display all Energy log information in standard engineering units.

2. System software shall be capable of graphing the Energy log data. Software shall be capable of creating graphs in the same format as trends log indicated earlier.
3. Operator shall be able to change the Energy log setup information as well. This includes which meters to be logged and meter pulse value. All meters monitored in the system may be logged. All operations shall be password protected.

2.2 GLOBAL CONTROLLER

A. General:

1. The global controller shall provide battery backed real time clock functions. It shall also provide system communications to programmable and application specific controllers in the field. Global controllers shall share information in a Peer-to-Peer manner utilizing a high-speed LAN communication network over common network speeds used by the Owner's communication network in the building.
2. Programming shall be object oriented using control program blocks. Provide documentation in flow chart form for all programming as part of the final system As-Built documentation.
3. Provide means to view inputs and outputs to each program block in real time as program is executing.
4. Communication to field devices shall be via individual two wire communication trunk(s). Communication baud rates 78,000 baud or higher.
5. System shall be furnished with a controller that resides on a High-speed Ethernet LAN. Each controller must be capable of directly accessing all points of connected unit controllers whether physical, pseudo or logical type, or Software points and values.

B. Remote Communications:

1. Provide Windows latest version compatible software utilized by PHSC, which allows operator to view and change all information, associated with system on color graphic displays. Operator shall be able to change all parameters in this section from off-site location including all programming of global controllers and programmable terminal unit controllers.

C. Schedules:

1. Each Global Controller shall have at a minimum:
   64 Weekly time schedules (7 day).
   64 Holiday schedules (300 programmable days each).
   20 Event schedules (300 programmable days each).
2. Each schedule may be assigned to any point, controller, or program in the system.
3. Each schedule (Weekly, Holiday and Event) shall be capable of performing an optimum start. Optimum start calculation shall be based on outside air temperature and zone air temperature.
4. Holiday schedule shall be provided to allow operation of system based on different schedule on specified holidays.
5. Event schedules shall be identical to Holiday schedule format and requirements.

6. Operator may define and setup all schedule information, via portable computer on site or via remote communications. This includes all times, dates and optimum start parameters. These functions shall be password protected.
7. Morning “Cool-Down” and “Warm-Up” control sequences (60 minute pre-“Occupied” schedule) shall be implemented per the building’s “occupied” schedule.
8. Temperature Control Panels: Provide U.L. listed temperature control panels of the latest design, for factory-mounting of all switches, relays, terminal blocks and any other panel-mounted equipment required for a completely functional temperature control system. The control panels shall have a cabinet door supported by a piano type hinge and a master key-locking latch. The panel shall be made of steel or extruded aluminum, with proper bracing for rigid wall or floor mounting. Mark each control device on the panel with engraved nameplates describing its function and cross-referencing it to the control diagrams.

2.3 TERMINAL UNIT CONTROLLERS (VAV’s)

A. General:

1. Provide programmable and application specific Terminal Unit Controller as needed to comply with sequence of operation, point list and drawings. All Terminal Unit Controller units shall be completely stand-alone with no loss of control if communication with global controller is interrupted. All control parameters; DDC programs and local variables such as set-point information shall be stored in EEPROM on board each Terminal Unit Controller allowing the operator to change information as desired.
2. All points on drawings, in sequence of operation and on point list shall be connected to and controlled by DDC units.
3. Communication shall be via two-wire communication trunk as specified above. Any type of Terminal Unit Controller shall communicate on the same communication trunk. System shall communicate to one Terminal Unit Controller regardless of whether other Terminal Unit Controllers on the same communication line are powered and connected.

B. Programmable Terminal Unit Controllers:

1. Each programmable Terminal Unit Controller shall be completely programmable via field computer or via remote communications.
2. This controller shall be programmed to perform custom strategies for system based on information from all points in the field.
3. Program and program parameters shall be stored in EEPROM. Battery backed RAM shall not be accepted for this level of controller.

C. Application Specific Terminal Unit Controllers:

1. Application Specific Terminal Unit Controllers shall be completely stand-alone controllers for unitary type controls such as VAV terminal boxes, heat pumps, AC units, fan coils, etc. All programs shall be resident in controller for complete stand-alone operation.
2. EEPROM technology shall be used for storage of program parameters such as set points, limits, etc., controllers utilizing a battery for backup of program parameters shall not be allowed.

2.4 TEMPERATURE SENSORS

A. General:

1. All temperature sensors to be solid-state electronic, factory calibrated to within one-half degree F, totally interchangeable. Wall sensors to be housed in enclosure appropriate for application. Duct and well sensors will be electronically identical with housing appropriate for application. Provide appropriate wells for installation by others.
2. Provide Digital display zone sensor for all wall sensors unless indicated otherwise on drawings.

B. Digital Display Zone Temperature Sensor:

1. Sensor may contain digital display and user function keys along with temperature sensor or have blank plate, as defined by owner. Sensor may function as occupant control unit and allow occupant to raise and lower set-point and activate terminal unit for night override use all within limits as programmed by building operator. Sensor shall also allow service technician access to terminal unit controller functions for use as system setup and test and service tool. Systems that require a Hand-held field service tool shall furnish a minimum of one (1) to the owner.
2. Provide means for occupant to view room set-point, room temperature and outside air temperature at each controller. Override time may be set and viewed in 0.1-hour increments. Override time count down shall be automatic, but may be reset to zero using function keys on unit.
3. Display shall also be used for status and alarm indication as described in the sequence of operation.

C. Web Browser Clients:

1. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer J or Netscape Navigator J. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
2. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the FMCS, shall not be acceptable.
3. The Graphical User Interface provides the Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
4. The Web browser client shall support at a minimum, the following functions:

    a. User log-on identification and password shall be required. If unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
    b. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.

5. Storage of the graphical screens shall be in the fileserver, without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
6. Real-time values displayed on a Web page shall update automatically without requiring a manual refresh of the Web page.
7. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to modify common application objects, such as schedules, calendars, and set points in a graphical manner.

8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.5 INSTRUMENTS AND CONTROLLED DEVICES

A. Transmitters/Transducers:

1. Provide special transmitters and sensors for specific applications as required. Transmitters shall provide an industry standard process signal across an acceptable range of engineering units such as 2-10vdc, 4-20mA.

B. Humidity Sensors:

1. Where specified Humidity sensors shall be by Veris Industries, KMC Controls, or Mamac Systems.

C. Control Valves:

1. Control valves shall be two-way pattern as shown, constructed for tight shutoff and shall operate satisfactorily against system pressures and differentials. Valves with sizes up to and including 2" shall be "screwed" with 250 psi ANSI pressure body rating; 4" and larger valves shall be 'flanged' configuration. Control valves shall be sized for a maximum pressure drop of 5.0 psig at rated flow. Approved manufacturer is: Belimo Air Controls.
2. Provide a two-position or modulating control valve based on the sequence required. Provide characterized ball valves or globe for all applications 2@ or under and globe valves for application over 2-1/2@ or larger.

D. Motorized Control Dampers:

1. Motorized dampers shall be low leakage, parallel-blade for two-position control and low-leakage, opposed-blade for proportional control applications. Dampers shall be selected for externally mounted actuators/damper motors. Damper frames shall be double-flange, 16-gage galvanized steel for return, relief and exhaust air systems. Leakage through the damper shall not exceed 10 CFM per square foot at 4" w.g. (based on a 48" x 48" test sample). Approved manufacturers are: TAMCO (Basis of Design).

2. Return Air and Exhaust Air Damper: low-leakage, heavy duty, opposed blade, rods and frames shall be extruded aluminum, including all hardware associated with the construction of the dampers. BASIS OF DESIGN: TAMCO SERIES 8000-SW. External mounting with standoff bracket.

3. Outside Air Dampers: low-leakage, heavy duty, opposed blade, rods and frames shall be extruded aluminum, including all hardware associated with the construction of the dampers. BASIS OF DESIGN: TAMCO SERIES 8000-SW. External mounting with standoff bracket.

E. Valve and Damper Motors:

1. Electric/Electronic Damper and Valve actuator motors shall be external mount, gear-driven direct coupled mounting. All damper actuators shall be floating, modulating or two-position as indicated. Actuators shall be sized to allow for sufficient torque for the given application to prevent stalling or binding. All Actuators shall have clutch release mechanisms to allow manual opening and closing of damper or valve. Approved manufacturers are: Belimo Air Controls.

F. Air Monitoring:

1. Provide thermal anemometer type sensing to calculate and measure air flow where specified. Provide equipment by Ebtron Inc. Model shall be Ebtron Gold Series, GP1 Duct and Plenum Sensors with digital transmitter.

G. Carbon Dioxide Monitoring:

1. Provide a duct-mounted carbon dioxide transmitter in the return air duct of the Air handling unit to transmit the CO_2 levels in PPM using a 4-20mA-process signal. Utilize a range as close to 0-2000ppm as possible to have instrument reading in mid-range. The building shall have an outside air CO_2 monitor for comparison. Provide instruments by Veris Industries or Kele & Associates.

H. Nitrogen Dioxide/Carbon Monoxide Monitoring: (Apparatus Bays)

1. Provide multiple wall-mounted, digital nitrogen dioxide/carbon monoxide sensors/transmitters in the Apparatus Bay of the Main Fire Station and open bays of the Logistics Building to transmit the $NO_{2/}$ and CO levels using a 4-20mA-process signal. Provide Duo-Sense/GG-CO-NO2-WH to include protective wire-guard accessory. Electrical Power requirements shall be 24VDC regulated. Output (2) Linear4/20MA outputs.
2. CO Sensor: 0-200 ppm; NO2 Sensor: 0-10 ppm.
3. Enclosure: NEMA 3RX.
4. Detection: Electro-chemical (diffusion method).

2.6 CONTROL WIRING

A. All conductors shall be #18AWG unshielded stranded wire meeting all building codes and regulations for fire ratings.

1. All conductors for analog inputs to be 22/2AWG shielded cable.
2. All room sensors shall be 22/4AWG non-shielded manufactured as LOGISTAT cable.
3. All analog outputs shall be 18/2AWG shielded cable.
4. All digital inputs shall be 22/2AWG non-shielded cable.
5. All digital outputs shall be 18/2AWG non-shielded cable.

B. Communication wiring shall be 22/2AWG low capacitance manufactured as ARC156 cable.

C. Label and land all wiring on termination strips.

1. Properly support all wiring and conduit and run in a neat and workmanlike manner.
2. All wiring and conduit exposed and in equipment rooms shall run parallel to or at right angles to the building structure.
3. All piping and wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals.

D. Do not pull bond or ground in conduit with sensor or communication wiring.

2.7 EQUIPMENT

A. All 24-VAC power for valve actuators, damper actuators and sensors shall be from dedicated 120/24VAC transformers and shown on control installation/shop drawings.

B. All DDC control panels serving the building shall be provided with minimum 1-hour UPS power supplies to maintain continuous power at each control panel.

C. Provide surge protection for exterior EMS points, and for communication or EMS points that travel between buildings. Communications between buildings will be by owner provided fiber optic cable.

D. EMS Contractor shall be responsible for all electrical installation required for a fully functional EMS and not shown on the Division 26 plans or required by the Division 26 specifications.

1. All wiring shall be in accordance to all local and national codes.
2. Install all control voltage wiring in conduit.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

B. Notify the Owners Representative or Contractor in writing of conditions detrimental to the proper and timely completion of the work.

3.2 INSTALLATION (GENERAL)

A. Install in accordance with manufacturer's instructions.

B. Provide all miscellaneous devices, hardware, software, interconnection installation and programming required to insure a complete operating system in accordance with the sequences of operation and point schedules.

3.3 LOCATION AND INSTALLATION OF COMPONENTS

A. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum 3'-0" clear access space in front of units. Obtain Owner Representative or Contractor’s approval on locations prior to installation.

B. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration and high temperatures.

C. Identify all equipment and panels. Provide permanently mounted tags to all panels.

D. Provide stainless steel or brass thermal wells suitable for respective application and for installation under other sections; sized to suit pipe diameter without restricting flow.

E. Install air flow monitoring stations in all outside air intake and relief air ductwork for energy recovery ventilators, outside air intake for each air handling unit and elsewhere as indicated.

3.4 INTERLOCKING AND CONTROL WIRING

A. All wiring shall be installed in a neat and professional manner in accordance with Division 26 and all state and local electrical codes.

B. Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions.

C. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Any requirement for wiring outside of buildings shall use Fiber Optic cable except within mechanical/electrical equipment.

D. Provide auxiliary pilot duty relays on motor starters as required for control function.

E. All control wiring shall be installed in raceways.

F. Division 26 shall be responsible for furnishing 120-vac control power to all control panels and 120-vac powered devices. Division 26 shall provide 120-vac control power for all magnetic motor starters at the starter.

3.5 FIELD SERVICES

A. Prepare and start DDC System under provisions of this section.

B. Start-up and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

C. Provide Owner's Representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

3.6 TRAINING

A. Provide application engineer to instruct owner in operation of systems and equipment.

B. Provide full operator training for a minimum of 3 persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs.

C. Provide 40 hours of training as part of this contract. Training shall be in three sessions as follows:

1. Initial Training: One-day session (8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that Owners' operating personnel can familiarize themselves with system before building is occupied.
2. First Follow-Up Training: Two days (16 hours total) approximately two weeks after initial training, and before Final Acceptance to discuss more advanced topics and answer questions.
3. Warranty Follow Up: Two days (16 hours total) in not less than 4-hour increments, to be scheduled by Owner during the two-year warranty period. Sessions shall discuss how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

D. Printed documentation of programming shall be furnished as part of the Owner’s training.

E. Provide text graph screens showing sequences of operation for each piece of equipment.

3.7 DEMONSTRATION

A. Provide systems demonstration under provisions of Section 23 01 00.

B. Provide all material and labor to provide full participation with the Commissioning Agent for the project as required. Participation shall also include repeat functional testing, programming, etc. of the control system as required based upon the commissioning agent's deficiency log in order to resolve any control related issues or functions.

PART 4 – CONTROL SEQUENCES

4.0 SEQUENCE OF OPERATIONS

A. Refer to the contract drawings for related control sequences for the project.

END OF SECTION 23 09 23

SECTION 23 23 13
REFRIGERANT PIPE, VALVES AND SPECIALTIES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Provide refrigerant piping systems, complete in all respects, between the system components and connected equipment. All refrigeration pipe sizing, traps, valves and other accessories shall be approved by the AHU/CU manufacturer’s technical requirements.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division-23 and to all other applicable portions of the Drawings and Specifications.

1.4 SHOP DRAWINGS

A. Refer to the Section entitled "General Mechanical Provisions".

PART 2 - PRODUCTS

2.1 COPPER PIPE

A. Refrigerant system piping shall be ASTM B 88, Type L (refrigerant grade), dehydrated and sealed, seamless, uniformly dead soft temper.

2.2 FITTINGS

A. Refrigerant grade, Type L, copper tubing, long radius, solder joint type. ASME B16.22.

2.3 SOLDER

A. Silver brazing alloy (Sil Fos) Fed. Spec. AA-S-56ld.

2.4 FLUX

A. Non-corrosive, specifically designed for silver brazing.

2.5 VALVES AND SPECIALTIES

A. Service Valves: 500-psig pressure rating; forged-brass body with copper stubs, brass caps, removable valve core, integral ball check valve, and with solder-end connections.

B. Solenoid Valves: Comply with ARI 760; 250 deg F (121 deg C) temperature rating and 400-psig (2760-kPa) working pressure; forged brass, with polytetrafluoroethylene valve seat, 2-way, straight-through pattern, and solder-end connections; manual operator; fitted with suitable NEMA 250 enclosure of type required by location, with 1/2-inch (16-GRC) conduit adapter and normally open/close holding electric coil.

C. Thermostatic Expansion Valves: Comply with ARI 750; brass body with stainless-steel parts; thermostatic-adjustable, modulating type; size and operating characteristics as recommended by manufacturer of evaporator, and factory set for superheat requirements; solder-end connections; with sensing bulb, distributor having side connection for hot-gas bypass line, and external equalizer line. TXV's shall be provided to meet the requirements of the AHU/CU system manufacturer. Trane (Basis of Design) recommends a 30% bleed port TXV for 20-60T Units.

D. Straight or Angle-Type Strainers: 500-psig (3450-kPa) working pressure; forged-brass or steel body with stainless-steel wire or brass-reinforced Monel screen of 80 to 100 mesh in liquid lines up to 1-1/8 inches (30 mm), 60 mesh in larger liquid lines, and 40 mesh in suction lines; with screwed cleanout plug and solder-end connections.

E. Moisture/Liquid Indicators: 500-psig maximum working pressure and 200 deg F (93 deg C) operating temperature; all-brass body with replaceable, polished, optical viewing window with color-coded moisture indicator; with solder-end connections.

F. Replaceable-Core Filter-Dryers: 500-psig (3450-kPa) maximum working pressure; heavy gage protected with corrosion-resistant-painted steel shell, flanged ring and spring, ductile-iron cover plate with steel cap screws; wrought-copper fittings for solder-end connections; with replaceable-core kit, including gaskets and the following:

1. Filter Cartridge: Pleated media with integral end rings, stainless-steel support, ARI 730 rated for capacity.
2. Filter-Dryer Cartridge: Pleated media with solid-core sieve with activated alumina, ARI 730 rated for capacity.

PART 3 - EXECUTION

3.1 PIPE SIZES

A. Refrigerant pipe sizes and parameters "MUST" be approved by the equipment manufacturer's requirements. Provide sizes not less than sizes indicated and in compliance with size recommended by the manufacturer(s) at the connected equipment. Provide change in sizes if such change is in accord with manufacturer's recommendation and with Architect/Engineer's approval. Size piping to maintain minimum velocity of 500-fpm in horizontal lines and 1000 fpm in vertical risers for proper oil return; provide double suction risers and hot gas risers as may be necessary to accomplish this.

3.2 REFRIGERANT SPECIALTIES

A. Refrigerant valves, driers, expansion valves, and similar items shall be provided with each system. Where refrigerant access valves are not furnished by the manufacturer, they shall be field installed to enable charging and checking the system.

3.3 JOINTS AND CONNECTIONS

A. General: All joints and connections shall be made permanently refrigerant tight.

B. Solder Joints: Cut tubing square using tubing cutters, with sharp cutting wheels, so as not to crimp the tubing ends. Remove all burrs using a pipe reamer and taking care not to flare the ends of the tube. Thoroughly clean the outside of the pipe and the inside of the fitting using a fine sand cloth. Apply non-corrosive paste flux to the cleaned surfaces immediately and apply silver solder and heat in accordance with manufacturer's instructions. Use care not to damage equipment or refrigerant specialty items when making up joints (protect from excessive heat). All Brazing procedures must meet the equipment manufacturer’s requirements.

C. Scale Prevention: During brazing, keep pipe system full of inert gas to prevent scale formation.

D. Mechanical Joints: Where the Contractor uses refrigerant tubing sets, follow the manufacturer's installation instructions explicitly, including the use of special tools, when making up the joints. Where pre-charged tubing and equipment is provided, do not cut into the system to install access valves.

3.4 HANGERS AND SUPPORTS

A. Refer to other sections describing hangers and supports. Isolate copper tubing from contact with any dissimilar metals.

3.5 EVACUATION AND CHARGING

A. When other than completely factory charged equipment and piping systems are used, they shall be evacuated and charged as follows: Charge the system with dry nitrogen and refrigerant and leak test all joints including factory piping within the units. Repair all leaks by disassembling and remaking the joint. After all leaks are corrected, evacuate the system to an absolute pressure of 0.2" mercury. System shall hold this vacuum for twelve hours with no noticeable rise in pressure. After passing vacuum test, break vacuum twice using refrigerant and re-evacuate for a minimum of two hours each time. Charge the system in the manner and with the type and amount of refrigerant specified for the equipment and in accordance with accepted refrigeration practice and equipment manufacturer’s requirements.

3.6 REFRIGERANT PIPING CONDUIT

A. Install any refrigerant piping which is below slab or grade in Schedule 40 PVC piping. Size conduit as necessary to properly install piping. Provide long bend sweeps. Install so that conduit will drain and not trap water. Protect ends of conduit from entry by vermin, insects and water.

3.7 OTHER REQUIREMENTS

A. Arrange piping generally as shown and such that service access is facilitated. Keep refrigerant lines as short and direct as possible with a minimum number of joints. Provide sleeves through floors, walls or ceilings, sized to permit installation of full-thickness insulation; seal air tight after installation of piping and insulation.

B. Provide flexible piping arrangement in hot gas discharge line of compressor. Such arrangement shall consist of a piping loop or similar measure to prevent transmission of objectional vibration.

C. Provide a removable core filter-drier in liquid line. In-line filter-driers are acceptable in individual circuits of less than 10-ton nominal capacity. Provide a full size valved bypass around this filter-drier. Provide shut-off valves to isolate the filter drier while flow is through the bypass and also a shutoff valve in the bypass so that filter-drier can be put into use.

D. Provide a refrigerant charging connection in the liquid line upstream from the filter-drier.

E. Provide a moisture indicating sight glass in the liquid line downstream from the filter-drier. Install in vertical line if possible and a sufficient distance downstream from any valve such that the resulting disturbance does not appear in the glass.

F. Provide a filter-drier with isolating shut-off valves and with valved bypass only if compressor is not equipped with a suction line filter or screen.

G. Keep piping free from traps unless otherwise indicated. Install vertical pipe plumb. Pitch horizontal piping only where slope is desirable.

H. Provide shut-off valves at inlet and outlet to all condensers, receivers and evaporators to permit isolation for service. If possible, use angle valves to minimize pressure drop. Use angle valves in all cases at receivers. Use globe valves only when angle valves are impractical.

I. Provide solenoid valves upright in horizontal lines only, unless their design allows installation in vertical pipe.

J. Where compressor(s) do not have pump down control and the compressor(s) associated evaporator coil(s) do not have bottom suction header connections and the evaporator coil(s) are located above the compressor(s), then loop suction lines(s) to top level of coil to prevent liquid slugging.

K. To prevent erratic operation of thermal expansion valve, provide a suction line trap next to evaporator coil suction outlet with expansion valve bulb located between coil and trap. Provide only in suction lines which are level leaving coil outlet or which rise on leaving coil outlet. Trap not required when evaporator coil outlet suction line drops to compressor or suction header immediately after expansion valve bulb.

L. Replace filter-drier after system has been adjusted and pressures are established.

END OF SECTION 23 23 13

SECTION 23 31 00
METAL DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Provide complete duct systems as indicated. Systems shall include, but not be limited to, the following: outside air, exhaust air, and air conditioning supply and return air duct systems as shown in the drawings. Drawing scales prohibit the indication of all offsets, fittings, and like items; however, these items shall be installed as required for the actual project conditions at no change in contract price.

B. Items Included: This section generally includes, but is not limited to, the following major items:

1. Low Pressure sheet metal ductwork.
2. High Pressure sheet metal ductwork, round and rectangular (Single Wall).
3. Kitchen Hood Exhaust Ductwork.
4. Dryer Exhaust Ductwork.
5. Low pressure flexible ducts.
6. High pressure flexible ducts.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions" for related requirements. Refer to other sections of Division 23 and to other applicable portions of the Drawings and Specifications.

B. This section is directly related in particular to sections (which may or may not be included in this division) which describe the following:

1. Sections describing air handling equipment and fans.
2. Air distribution devices.
3. Terminal units.
4. Duct system accessories.
5. Insulation.

C. Coordinate shop drawings, ordering, delivery, and placement of all items affecting the duct systems including, but not limited to, the following items: air handling units, exhaust fans, supply fans, sound attenuators, duct mounted coils, access panels, air distribution devices, fire dampers, outside air louvers, hoods, filters, roof curbs, structural framing, roof construction, roofing, and the work of all trades to insure an orderly and timely progression of the work. Refer to the requirements of Section entitled "General Mechanical Provisions".

D. Refer to other sections which may describe additional sound attenuation measures which may relate to this section.

1.4 SHOP DRAWINGS

A. Refer to Section entitled "General Mechanical Provisions". Include complete data as applicable to this project on: all prefabricated duct and fittings; duct liner including mechanical fasteners and adhesives; duct sealing materials; duct joining and seaming methods; and all other items. If required by Architect, prepare and submit for approval completely detailed shop drawings of supply and return ductwork from any or each air handling unit through its transitions, bends and elbows until such ducts are extended beyond the air handling unit equipment area and/or congested areas; these shop drawings will not be required unless specifically called for elsewhere or unless significant deviation from the Drawings is necessitated by the equipment provided.

1.5 OTHER REQUIREMENTS

A. Provide all ductwork and components thereof in accord with manufacturer's recommendations. All ductwork dimensions indicated are nominal free clearance internal dimensions which do not include insulation thickness.

B. The sheetmetal contractor shall be involved in the pre-installation conference identified in the General Conditions specified in Division 23 Section 23 01 00,”General Mechanical Provisions”.

1.6 DEFINITIONS

A. "SMACNA" means "Sheet Metal and Air Conditioning Contractors National Association, Inc."

B. Low Pressure Ductwork: Any and all ductwork conveying air or other gases at velocities less than 2500 fpm and static pressure less than 2.0 inches wg. This ductwork may also be referred to in these specifications as "Low Velocity Ductwork". SMACNA "HVAC Duct Construction Standards, Metal and Flexible", Second Edition, 1995, shall govern construction of this ductwork unless otherwise specified.

C. Medium/High Pressure Ductwork: Any and all ductwork conveying air or other gases at velocities equal to or greater than 2500 fpm or static pressure equal to or greater than 2.0 inches wg. This ductwork may also be referred to in these specifications as "High Velocity Ductwork" or "Medium Pressure Ductwork", but shall be considered, in either terminology, to fall within pressure/velocity class (PV/C designation) 3 to 10. SMACNA "HVAC Duct Construction Standards, Metal and Flexible", Second Edition, 1995, shall govern construction of this ductwork unless otherwise specified.

1.7 PRESSURE/VELOCITY CLASSIFICATIONS

A. Pressure and velocity classifications (hereinafter called "P/VC") for ducts are defined as follows:

P/VC Desig.	SMACNA Pressure Class	Static Pressure Rating	Positive or Negative Pressure	SMACNA Seal Class	Maximum Velocity (fpm)
10	High	10"	+	A	2000 up
6	Medium	6"	+	A	2000 up
4	Medium	4"	+	A	4000 dn
3	Medium	3"	+ or -	B	4000 dn
2	Low	2"	+ or -	C	2500 dn
1	Low	1"	+ or -	C	2500 dn
½	Low	1/2"	+ or -	C	2000 dn

B. See Part 3, EXECUTION, of this section for duct sealing requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials shall comply with current SMACNA standards. Acceptable manufacturer's are

1. Ductmate Industries, Inc.
2. Engel Industries.
3. Nexus.
4. Ward.
5. Lockformer.

B. ASTM: Unless otherwise specified, ASTM material specifications applicable are:

Material	Type	ASTM Number
Galvanized steel	G90	A525
Stainless steel	304,304	A240
Cold rolled steel	20-28 ga.	A366
Cold rolled steel	18 ga.	A619
Aluminum	3003 H-14	B609

C. Special Materials, Gauges and Construction:

1. Special Materials: Where special duct material other than galvanized steel is required, such duct material (e.g., fiberglass, stainless steel, plastic such as polyvinylchloride, etc.) shall be specifically indicated.
2. Gauges: Gauges indicated in this section are for galvanized steel. Where greater or lesser gauges are specifically indicated for a sheet metal material other than galvanized steel, provide the indicated gauge. Comply with the SMACNA construction standard covering the required material if no gauge is given.
3. Construction: Comply with indicated special requirements (i.e., such as welding, soldering, etc.) where application requires.

2.2 LOW PRESSURE SHEET METAL DUCTWORK

A. Material: Prime quality forty-eight inch wide re-square tight coat galvanized steel conforming to the requirements of ASTM A-525 and/or A-527 as applicable to the intended use.

B. Construction:

1. Construct to comply with the pressure/velocity classification(s) indicated.
2. Use rectangular or round as indicated on drawings.
3. Reinforcing, Cross Breaking, Seams, Joints: Be in accord with latest SMACNA construction standard for low pressure sheet metal duct.
4. Gauge: As required by SMACNA for the dimensions and pressure/velocity classification involved.
5. ***NO SNAP-LOCK DUCTWORK IS PERMITTED ON THIS PROJECT.***

C. Insulation:

1. Rectangular rigid sheet metal ductwork: As specified in the Insulation section of Division 23.
2. Round rigid sheet metal ductwork: Where low pressure round ductwork is designated as double-walled construction, provide factory fabricated double-wall ductwork as specified for high pressure round acoustically lined sound attenuating duct (i.e., factory fabricated double wall duct with perforated inner wall).

2.3 HIGH PRESSURE DUCTWORK, ROUND AND FLAT-OVAL

A. General:

1. Comply with current SMACNA standards.
2. Factory fabricated portions shall be made by McGill Airflow, LLC, Semco or equal.

B. Straight Conduit: Galvanized steel unless otherwise indicated for a specific application.

1. Seam construction: Spiral lock-seam (SMACNA Type RL-1) allowed for all pressure/velocity classifications. Longitudinal grooved seam (SMACNA Type RL-5) allowed only up to pressure/velocity classification P/VC-3.

C. Fittings:

1. Material: Same as connecting duct system.
2. Configuration: Standard design as manufactured by United McGill, Semco or equal.
3. Elbows:

a. General: All mitered elbows must be vaned.
b. Round: 5-inch diameter and larger shall be five-section construction; less than 5-inches diameter shall be die-formed.
c. Flat-oval: Five-section construction.
d. Hard turn oval elbows shall have vanes as follows:

Equivalent diameters	Number of Vanes
10" through 14"	3
15" through 19"	4
20" through 60"	5
Over 60"	12" spacing

4. Vanes: Be minimum 20 gauge and limited to 24 inches of unsupported length. The leading edge of all vanes in duct exceeding 20 inch size will be hemmed with a 1/2 inch fold back.
5. Divided Flow Fittings: All divided flow configurations are to be furnished as separate fittings. Tap covers welded into spiral duct sections are not acceptable. All tees, crosses and laterals up to an including 12" diameter tap size, will have a minimum 3/8" radius

rounded entrance into the tap, produced by machining, press forming, or hand grinding to a smooth entrance. The entrance will be free of projections, weld buildups, burrs or irregularities. All fittings will have continuous welds along all seams.

6. Tees and Crosses: All tees and crosses shall be the spun conical type with branch entrances through 12" size, to be rounded laminar flow as noted above.
7. Connections: Connections of conduit to fittings shall be made with a synthetic rubber sealing compound conforming to NFPA 90A as to flame spread and smoke developed ratings and mechanically fastened with drive or twist screws, and all joints tested in accordance with test procedure described hereinafter. Raychem TDB duct sealing bands may be used in lieu of the sealing compound. Connection between conduit and terminals shall be made with a maximum of 48" of flexible duct. Run-out connections shall be assembled in same manner as conduit and fittings.

D. Gauge: Minimum gauge as follows (gauges are for round and flat-oval duct with spiral lock-seam construction unless otherwise indicated):

1. Round duct (galvanized steel):

Diameter (Inches)	Gauge	Alternate Gauge(2)
3 thru 8	26	24
9 thru 14	26	24
15 thru 26	24	22
27 thru 36	22	20
37 thru 50	20	20
51 thru 60	18	18
61 thru 84	18(1)	16

(1) Must be 16 ga. when static pressure is negative.
(2) *NO SNAP-LOCK DUCTWORK IS PERMITTED ON THIS PROJECT.*
Only factory reinforced spiral duct shall be allowed on low pressure ductwork and only for short connections to supply and return diffusers or fan vents. All Ductwork seams to be taped and mastic sealed completely.

2. Flat-oval duct (galvanized steel):

Major Dimension (Inches)	Gauge
0 thru 24	24
25 thru 36	22
37 thru 48	22
49 thru 60	20
61 thru 70	20
71 and up	18

E. Fittings:

1. Round duct: Same as duct unless otherwise recommended by manufacturer.

2. Flat-oval duct:

Major Dimension (Inches)	Gauge
0 to 24	20
25 to 36	20
36 to 48	18
49 to 60	18
61 to 70	16
71 and up	16

2.4 HIGH PRESSURE DUCTWORK, RECTANGULAR

A. General:

1. Airtight and structurally stable at maximum system operating pressure.
2. Any welding shall be continuous and corrosion resistant.
3. Galvanized sheet steel unless otherwise indicated for a specific application.
4. Reinforced and supported to neither cause nor convey any objectionable vibrations.
5. Be in accordance with latest SMACNA construction standard for high pressure ductwork.

B. Turning Vanes: Adequate rigidity and strength to be completely flutter-proof. Airfoil, permanently fixed type constructed of galvanized steel of aluminum with sound attenuating fiberglass inner liner with open protective metal facing. Quantity in each elbow in accordance with manufacturer's recommendations. Airsan Acoustiturn as made by Air Filter Corporation.

2.5 HIGH PRESSURE DUCT RELIEF AND ACCESS DOORS

A. Provide suitable size for access to heaters, dampers and other equipment installed in duct, and at other points indicated on drawings. Size shall be as listed by paragraph above and compatible with duct size but not smaller than 8"x12". Doors shall be 24 US gauge galvanized steel hinged to a 24 gauge galvanized mounting frame and for insulated duct shall be double panel construction with 1/2 inch rigid insulation material between metal panels. Doors shall be United Sheet Metal Type AR or an approved equal.

2.6 LOW PRESSURE FLEXIBLE DUCTS

A. General:

1. The inclusion of flexible ducts in this specification shall not be construed as approval of use on the project unless specifically shown on the Drawings.
2. Where used, provide in factory finished lengths not in excess of lengths required to make kink-free connections with minimum air pressure drop.

B. Insulated flexible ducts: Flexible duct shall be factory-fabricated pre-insulated type with seamless vapor barrier. Duct shall bear UL 181 Class 1 Air Duct label and shall comply with NFPA 90A and 90B. Fiberglass insulation nominal 1" thickness with thermal conductance of 0.23 BTU/hr-ft2-^{o}F maximum at 75^{o}F mean temperature. Flexible duct shall have an operating range of minus 0.5" w.g. to plus 2" w.g. Core shall be continuous and consist of aluminized mylar laminated to corrosion resistant steel wire helix. Vapor barrier perm rating shall be 0.17 maximum per ASTM E96-A. Maximum working velocity shall be 4000 FPM. Flexible duct shall

be Genflex SLR-25, Clevaflex Type KQ, Wire Mold type WG, Flexmaster Type 5B, or approved equal.

C. Round branch take-off fittings for flexible duct:

1. Round duct branch take-off fitting shall be made of galvanized sheet metal designed for twist-in installation and to assure minimum air loss at the take-off. The fittings shall be of the conical converging type to reduce the pressure drop through the fittings. Provide a raised bead on the throat of the fitting to assure a tight positive connection. Products shall be Flexmaster Model CB-DE-BO3 or approved equal.
2. Provide each fitting with the following:

   a. Lockable quadrant damper.
   b. 45-degree extractor scoop.
   c. Insulation guard where used with internally lined ductwork.

3. Provide these "spin-in" type fittings at all connections between rigid sheet metal duct and flexible duct at the upstream end of the flexible duct.

2.7 HIGH PRESSURE FLEXIBLE DUCTS

A. Meet all requirements for low pressure flexible ducts except be recommended by manufacturer for high pressure application.

2.8 RIGID STAINLESS STEEL EXHAUST DUCTS

A. Exhaust Ducts for Kitchen Ventilation Hoods:

1. Construct primary kitchen ventilation hood system and dishwasher ventilation system hood exhaust ducts of 20 gage stainless steel ANSI type 304, mill finish. Joints and seams shall be liquid-tight, continuously welded per NFPA 96.
2. Ductwork in exposed locations shall have No. 4 polished finish.

2.9 RIGID ALUMINUM DRYER DUCTS AND ACCESSORIES

A. Exhaust Ducts and Accessories for Dryers:

1. `Construct dryer ductwork of 20 gage aluminum ductwork and fittings. *No sheetmetal screws* or duct tape shall be permitted for joint connections of the dryer duct.
2. Dryer Duct Vent Box: Provide a metal, painted pre-fabricated, recessed dryer duct vent box for a 4-inch dryer duct. Box shall include a full perimeter trim flange.
3. Wall Discharge Cap: JEDCO Model # GVHAW4, Heavy-duty construction with louvered backdraft/bird/rodent guard assembly, pipe/collar sleeve assembly.
4. Booster Fan and Accessories: Provide an in-line dryer booster fan and accessories where indicated on the drawings, or where necessitated by manufacturer's developed length considerations. Provide FANTECH Model # DBF4XLT-705 UL-LISTED DEDPV (Dryer Duct Power Ventilator). Includes LED indicator display panel, temperature limit switch. Provide two-piece clamp accessory kit.

PART 3 - EXECUTION

3.1 GENERAL

A. All duct systems shall be free of noise, chatter, vibration and pulsation under all conditions of operation. Remove, replace or reinforce as directed by the Architect/Engineer if necessary to correct such conditions.

B. If field conditions are determined to exist which would limit the guarantee of air delivery or system performance, due notice in writing shall be submitted to the Architect/Engineer of such conditions prior to starting fabrication.

C. Properly support and align ductwork. Ducts to be free of sag and bulge. Hang ductwork below concrete floors or roof deck with hangers set prior to pouring concrete, or from self drilling screw anchors. GUN POWDER SET ANCHORS ARE NOT PERMITTED.

D. Where it is necessary that ducts be divided due to pipes or other obstructions which must pass through these ducts, the Contractor shall, at locations as noted or directed, provide air-stream deflectors in the duct and the duct shall be increased in size to maintain equivalent area around deflectors. Such changes shall be in accord with standard SMACNA details and shall be shown on Contractor's As-Built Drawings.

E. Interior of ductwork visible through registers, grilles, or diffusers shall be painted flat black.

F. Do not route ductwork through transformer vaults and electrical equipment spaces and enclosures.

G. Construct all ductwork and accessories in accord with the latest indicated editions of applicable SMACNA construction standards. Sheet Metal and Air Conditioning Contractors' National Association.

H. Streamline all ductwork to the full extent practical and equip with proper and adequate devices to assure proper balance and quiet draftless distribution of indicated air quantities.

I. Protect all ductwork and system accessories from damage during construction until Architect/Engineer's final acceptance of project.

J. Prior to ductwork fabrication, verify if all ductwork as dimensioned and generally shown will satisfactorily fit allocated spaces. Take precautions to avoid space interferences with beams, columns, joists, pipes, lights, conduit, other ducts, equipment, etc. Notify Architect/Engineer if any spatial conflicts exist, and then obtain Architect/Engineer's approval of necessary routing. Make any such necessary revisions which are minor at no additional cost.

K. Carefully correlate all duct connections to air handling units and fans to provide proper connections, elbows and bends which minimize noise and pressure drop.

L. Provide all curved elbows with radius ratios of not less than 1.5 unless otherwise shown or approved by Architect/Engineer. Provide all mitered elbows with turning vanes.

M. Properly suspend all ductwork so that no objectionable conditions result (such as vibration, sagging, etc.).

N. Coordinate any and all dimensions at interfaces of dissimilar type of ductwork and at interfaces of ductwork with equipment so that proper overlaps, interfaces, etc., of insulation and continuity of vapor barriers are maintained.

O. If necessary where ducts interface and have different types of insulation, provide transitions so that internal free-clear dimensions of duct remain unchanged.

P. Install horizontal low pressure ductwork at a level which maximizes length of any vertical, rectangular or round rigid duct connections to rectangular diffuser necks; however, such vertical duct connections are not required to be over 24 inches in length.

Q. Make connections from any high pressure ductwork to terminal units (fan terminal units, variable volume boxes, etc.) with appropriate lengths of flexible duct unless other type of connection is indicated.

R. Install all flexible round duct without kinks or similar obstructions so that pressure drop is minimized. Cut and remove excess lengths as necessary.

S. Install horizontal rigid ductwork as high as practical above suspended ceilings so that movable light fixtures may be relocated without interference to meet any future partition relocation requirements.

T. Insulated Duct: Where ducts will be insulated, make provision for neat insulation finish around damper operating quadrants, splitter adjusting clamps, access doors, and similar operating devices. A metal collar equivalent in depth to insulation thickness and of suitable size to which insulation may be finished shall be mounted on duct.

3.2 LOW PRESSURE SHEET METAL DUCTS

A. If width or height of rectangular duct exceeds 12 inches, cross break or roll a cross bead in panels to increase stiffness; otherwise, use two gages heavier steel.

B. Provide corner closures. Longitudinal seams and transverse joints shall be flat and smooth inside. Make slip joints in direction of air flow. See governing SMACNA manual for transition requirements.

C. Fabricate offsets, turns and elbows with centerline radius equal to 1-1/2 times diameter when possible. No mitered offsets will be allowed. Provide double thickness turning vanes to assist in smooth flow of air in square elbows or elbows with centerline radius less than duct width or diameter.

3.3 HIGH PRESSURE DUCTWORK

A. In addition to other requirements, this ductwork shall be as follows:

1. Any welds shall be continuous and corrosion resistant.
2. Reinforced and supported to cause and/or to convey no objectionable vibrations.
3. All seams and joints permanently sealed and joined in strict accordance with the manufacturer's recommendations.

B. Conical Tees: Make all branch duct take-offs and all connections to flexible duct supplying air to terminal units with conical tees.

3.4 LOW PRESSURE FLEXIBLE DUCTS

A. Flexible ducts shall not be used unless specifically indicated on drawings.

B. If flexible duct is indicated for use on this project, it must comply with the following requirements.

1. The extent of the use of flexible ductwork shall be limited to that shown on the drawings.
2. Connect flexible ductwork to collars on rigid ductwork and diffuser collars and terminal devices with stainless steel worm gear driven type locking clamps. Stainless steel ductwork shall be secured with stainless steel bands and clamps only. *Plastic Cable or "ZIP" Ties are not permitted to connect ductwork.*
3. Flexible duct installation shall be per SMACNA Flexible Duct Installation Standards, and manufacturers latest printed instructions, whichever is stricter. In addition the following shall apply:

    a. Flexible duct between rigid duct and diffusers shall be a MAXIMUM of 6 feet in length and shall be fully extended with a maximum equivalent of (2) 90 degree bends (no bend shall be made with centerline radius of less than one duct diameter). No additional flexible duct shall be provided for future terminal device relocation unless otherwise specified.
    b. Flexible duct shall be supported at ends and at each 90 degree bend. Maximum permissible sag is 1/2 inch per foot of spacing between supports.
    c. Hanger or saddle material in contact with the flexible duct shall be of sufficient width to prevent any restriction of the internal diameter of the duct when the weight of the supported section rests on the hanger or saddle material. In no case will the material contacting the flexible duct be less than 1 inch wide. Narrower hanger material may be used in conjunction with a sheet metal saddle which meets the foregoing specifications. This saddle must be formed to cover one-half the circumference of the outside diameter of the flexible duct and must be rolled to fit neatly around the lower half of the duct's outer circumference.
    d. Factory installed suspension systems integral to the flexible duct are an acceptable alternative hanging method when manufacturers recommended procedures are followed.
    e. Hangers shall be adequately attached to the building structure (not pipe, conduit, etc.).
    f. To prevent tearing of vapor barrier, do not support entire weight of flexible duct on any one hanger during installation. Avoid contact of flexible duct with sharp edges of hanger material. Damage to vapor barrier may be repaired with approved tape. If internal core is penetrated, replace flexible duct or treat as a connection.

4. Terminal devices connected by flexible duct shall be supported independently of the flexible duct.

3.5 HIGH PRESSURE FLEXIBLE DUCTS

A. Shall be suitable for use in medium pressure systems and used at the inlets to the VAV terminals.

3.6 RIGID STAINLESS-STEEL DUCT (KITCHEN VENTILATION HOOD EXHAUST)

A. In addition to SMACNA recommendations and other requirements, rigid stainless-steel duct systems shall comply with the following:

1. All joints and seams shall be made with continuous welds. Ductwork shall be liquid tight and gas tight.
2. Hangers and supports in finished areas shall be of same material as ductwork.
3. Strip away protective paper from stainless steel surfaces only after all construction is complete. Grind and polish all welded seams, repair finish wherever damaged to its specified quality.

3.7 MISCELLANEOUS DUCT SYSTEM COMPONENTS

A. Spin-In Take-Off Fittings: Install around duct branch takeoff fittings according to manufacturer's installation instruction. Additionally, seal fitting to rectangular duct with a thin bead of mastic sealant.

3.8 HANGERS AND SUPPORTS

A. General: Comply with latest applicable SMACNA construction standard. Where sprayed fireproofing occurs, install hangers before application of such treatment and withhold installation of ducts until after application.

B. Supports: Vertical risers and other duct runs where the method of support specified above is not applicable shall be supported by substantial angle brackets designed to meet field conditions and installed to allow for duct expansion.

C. Fasteners: Secure hangers to steel beams or metal deck with beam clamps or drop through connections from the metal or concrete deck.

3.9 CHANGES IN SHAPE OR DIMENSION

A. Where duct size or shape is changed to effect a change in area, the following shall apply:

1. Where the area at the end of the transformation results in an increase in area over that at the beginning, the slope of the transformation shall not exceed one inch in seven inches.
2. Where the area at the end of the transformation results in a decrease in area from that at the beginning, the slope of the transformation may be one inch in four inches, but one inch in seven inches is preferable, space permitting.
3. The angle of transformation at connections to heating coils or other equipment shall not exceed thirty degrees from a line parallel to the air flow on the entering side of the equipment, nor fifteen degrees on the leaving side. The angle of approach may be increased to suit limited space conditions when the transformation is provided with vanes approved by the Architect/Engineer.

3.10 CHANGES IN DIRECTION

A. Changes in direction shall be basically as indicated on the drawings and the following shall apply:

1. Supply duct turns of ninety degrees in low pressure duct shall be made with mitered elbows fitted with closely spaced turning vanes designed for maintaining a constant velocity through the elbow.
2. Return and exhaust duct turns of ninety degrees in low pressure duct shall be made with mitered elbows, as specified hereinbefore for supply ducts, unless radius elbows are indicated in which case they shall be constructed with a turning radius one and one-half (1-1/2) times the width (with width considered as the dimension in the plane of the turn) as measured to the duct centerline.
3. Tees in low pressure duct shall conform to the design requirements specified hereinbefore for elbows.
4. Branch take-offs in low pressure supply duct shall be made with extractors or splitter dampers, as indicated, in square take-offs.
5. In high pressure duct, branch take-offs and connections to flexible duct supplying air to terminal units shall be made with conical taps.

3.11 IMPROPER MATERIALS OR CONFIGURATION

A. If ductwork materials or ductwork configurations are installed which do not meet these specifications, Contractor shall remove such ductwork and replace with materials or configurations which are acceptable. Any delay in job progress will be the responsibility of the Contractor.

3.12 OTHER REQUIREMENTS

A. Insulated Duct: Where ducts will be insulated, make provision for neat insulation finish around damper operating quadrants, splitter adjusting clamps, access doors, and similar operating devices. A metal collar equivalent in depth to insulation thickness and of suitable size to which insulation may be finished shall be mounted on duct.

B. Control Devices: Properly install all control related devices which are part of the duct systems. See Section(s) describing control systems.

C. Duct Liner: All duct liner shall be installed per the manufacturer's directions. Provide metal closure strips where lined/unlined duct transitions in each system. Provide mechanical fastener pins

3.13 SEALING OF DUCTS

A. Duct seal classes are as follows:

1. Seal class "A": Seal all transverse joints, longitudinal seams and duct wall penetrations. Use for P/VC-4 (4" w.g.) and greater unless otherwise indicated.
2. Seal class "B": Seal all transverse joints and longitudinal seams. Use for P/VC-3 (3" w.g.) unless otherwise indicated.
3. Seal class "C": Seal all transverse joints. Use for P/VC-2 (2" w.g.) and lower unless otherwise indicated.

B. Where sealing is required it shall mean the following:

1. The use of adhesives, gaskets, tape systems or combinations thereof to close openings in the surface of the ductwork and field-erected plenums and casings through which air leakage would occur; or
2. The prudent selection and application of sealing methods by fabricators and installers, giving due consideration to the designated pressure class, pressure mode (positive or negative), chemical compatibility of the closure system, potential movement of mating parts, workmanship, amount and type of handling; cleanliness of surfaces, product shelf life, curing time and manufacturer-identified exposure limitations;
3. That these provisions are applicable to duct connections to equipment and to apparatus but are not for equipment and apparatus;
4. That where distinctions between seams and joints are made herein, a seam is defined as joining of two longitudinally (in the direction of air-flow) oriented edges of duct surface material occurring between two joints. Helical (spiral) lock seams are exempt from sealant requirements. All other duct surface connections made on the perimeter are deemed to be joints. Joints are inclusive of but not limited to girth joints; branch and sub-branch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum and casing abutments to building structures; that sealing requirements herein do not contain provisions to:

a. Resist chemical attack.
b. Be dielectrically isolated.
c. Be waterproof, weatherproof or ultraviolet ray resistant.
d. Withstand temperatures higher than 120°F or lower than 40°F.
e. Contain atomic radiation or serve in other safety-related construction.
f. Be electrically grounded.
g. Maintain leakage integrity at pressures in excess of the duct classification herein.
h. Be underground below the water table.
i. Be submerged in liquid.
j. Withstand continuous vibration visible to the naked eye.
k. Be totally leak-free within an encapsulating vapor barrier.
l. Create closure in portions of the building structure used as ducts, e.g., ceiling plenums, shafts, pressurized compartments.

5. The requirements to seal apply to both positive pressure and negative pressure of operation.
6. Externally insulated ducts located outside of buildings shall be sealed prior to being insulated as though they were inside. If metal surfaces of ducts located on the exterior of buildings are exposed to weather, they shall receive exterior duct sealant. An exterior duct sealant is defined as a sealant that is marketed specifically as forming a positive air and water tight seal, bonding well to the metal involved, remaining flexible with metal movement and having a service temperature range of -30°F to 175°F. If exposed to direct sunlight it shall also be ultraviolet ray and ozone resistant or shall, after curing, be painted with a compatible coating that provides such resistance. The term sealant herein is not limited to materials of adhesive or mastic nature but is inclusive of tapes and combinations of open weave fabric strips and mastics.

C. Materials and applications for sealing ducts:

1. General:

a. Complete product data on all materials used for sealing ducts must be submitted for approval prior to any duct fabrication.
b. All sealants must be specifically recommended by their manufacturer for the purpose of sealing ducts.

2. Liquid Sealant:

a. Use only for slip type joints where sealant is to fill small space between overlapping pieces of metal. Do not use where metal clearances exceed 1/32-inch.
b. Sealant must be specifically manufactured for the purpose of sealing ducts.

3. Mastics:

a. Use in lieu of liquid sealant at Contractor's option.
b. Use as a fillet, in grooves and between flanges.
c. Do not use oil base caulking or glazing compounds.

4. Gaskets:

a. Use soft elastomer butyl or neoprene rubber or extruded forms of sealants in flanged joints in addition to mastic.

5. Tape:

a. Tape is not allowed on ducts.

6. Combination of mastic and embedded fabric:

    a. Use mastic/mesh/mastic as a sealant where pressure/velocity classification is equal to and exceeds P/VC-3 and where any spaces between metal surfaces at transverse joints or longitudinal seams or duct wall penetrations exceeds 1/16-inch.
    b. Apply glove coat of mastic, then embed a continuous or overlapping strip of not less than 4-inch wide 10 x 10 fiberglass cloth into the mastic, then apply a final glove coat of mastic over the glass cloth.

7. Surface preparation:

    a. Surfaces to receive sealant should be adequately clean (free from oil, dust, dirt, rust, moisture, ice crystals and other substances that inhibit or prevent bonding). Use solvent and/or apply a face primer if necessary to obtain adequately clean surface for adhesion.

3.14 LEAKAGE TESTING

A. General:

1. Test the following duct systems:

    a. All ducts which are (1) under positive or negative pressure and (2) which are directly connected to air moving device (air handling unit, exhaust fan, supply fan or similar air moving equipment) and (3) which convey 1000-cfm or greater through their largest portion.
    b. All ducts which are (1) under positive or negative pressure and (2) which are part of a supply, return, outside and/or exhaust air system and (3) which are equal to or greater than 25 feet in length and (4) which may or may not be directly connected to an air moving device.

2. Portions of duct to be tested shall consist of all portions from the largest cross sectional area to the air distribution device connection or to the smallest inlet or outlet point, whichever is applicable.
3. Duct systems shall be constructed so that leakage does not exceed 5.00% of the air quantity handled by the respective fan.

B. Allowable Leakage:

1. Leakage shall be measured during leakage test at a test pressure which is equal to the pressure/velocity classification of the duct system (e.g., a P/VC-2 duct shall be tested at 2.0 in. w.g.s.p., a P/VC-1/2 duct at 0.5 in. w.g.s.p., etc.).

C. Test Procedure:

1. Test at time of duct installation and prior to installation of any field applied insulation and prior to any concealment in chases or similar enclosures.
2. Duct openings (both entry openings and outlet openings) shall be capped or sealed by taping or banding a flexible plastic sheet over each opening prior to pressurizing duct. The plastic sheet shall be of adequate strength and thickness to withstand the test pressures. Use other method of sealing duct openings providing objective of test is obtained and if method of sealing is approved by Architect/Engineer.
3. Use a fan having a minimum capacity of 300-cfm or 5% of the particular duct system design capacity, whichever is greater and which is capable of producing a duct test pressure of 150% of the duct test pressure.

4. Test fan shall be connected to a flow measuring assembly consisting of straightening vanes and an orifice plate mounted in a straight tube with appropriately located pressure taps. Orifice assembly shall be accurately calibrated with its own calibration curve. Pressures shall be measured with U-tube manometers and corresponding flow rates obtained from the orifice performance curve.
5. Connect test fan and orifice flow measuring assembly to the duct to be tested with a section of flexible duct.
6. Test for audible leaks as follows:

    a. Close off and seal all openings in the duct section to be tested. Connect the test apparatus to the duct by means of a section of flexible duct.
    b. Start the blower with its control damper closed (some small blowers popularly used for testing ducts may damage the duct because they can develop pressures up to 25 inches (W.G.).
    c. Gradually open the inlet damper until the duct pressure reaches 50% in excess of designed duct operating pressure.
    d. Survey all joints for audible leaks. Mark each leak and repair after shutting down blower. Do not apply a retest until sealing has been repaired if and where necessary.

7. After all audible leaks have been sealed, the leakage should be measured with the orifice section of the test apparatus as follows:

    a. Start blower and open damper until pressure in duct reaches 25% in excess of designed duct operating pressure.
    b. Total allowable leakage shall not exceed five (5) percent of the total system design air flow rate. When partial sections (such as supply section, return section, etc.) of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.

8. Correct any duct leaks which are detected either audibly or by touch regardless of whether leakage through duct system is less than allowable test leakage.

3.15 DEFINITIONS OF DUCT TYPES

A. Duct types shall be as follows:

1. Supply/Discharge Ductwork from VAV AHU's to the inlet of each VAV terminal unit High/Medium pressure ductwork/Seal Class A.
2. Supply Ductwork downstream/discharge side of the VAV terminal units - Low pressure ductwork/Seal Class C.
3. Supply/Return/OA Ductwork serving the Single or Multi- Zone and Single Path HVAC systems: Main supply air ductwork from the AHU supply air side - Low pressure ductwork/Seal Class C.
4. Toilet and Ventilation Exhaust Ductwork – Low pressure ductwork/Seal Class C.
5. Dryer Exhaust Ductwork – Aluminum. No sheet metal screws. Slip joint fittings with adhesive joint sealer.
6. Return Air Ductwork – Low pressure ductwork/Seal Class C.
7. Exhaust Ventilation Ductwork– Low pressure ductwork/Seal Class C.
8. O/A Ductwork and intake plenums at louvers– Stainless Steel, 20-gage, Low pressure ductwork/Seal Class C.
9. Kitchen Ventilation Hoods Exhaust Ductwork and Fittings – Stainless Steel, 20-gage, type 304 welded joint and seam construction.

END OF SECTION 23 31 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 33 00
DUCT SYSTEM ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Provide all necessary duct system accessories to assure proper balance, quiet and draftless distribution and conveyance, and minimization of turbulence, noise and pressure drop for all supply return, exhaust and ventilation air quantities indicated.

B. Items Included: This section generally includes, but is not limited to, the following items as may be applicable to this project:

1. Flexible duct connections.
2. Splitters.
3. Turning vanes.
4. Extractors.
5. Manual volume dampers.
6. Access doors.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 23 and to all other applicable portions of the Drawings and Specifications.

B. This section directly relates in particular to sections (which may or may not be included in this division) which describe the following:

1. Ductwork.
2. Air distribution devices.
3. All types of air handling equipment.

1.4 COORDINATION

A. Coordinate all items affecting the duct systems including but not limited to the following items: air handling units, exhaust fans, supply fans, sound attenuators, duct mounted coils, access panels air distribution devices, fire dampers, outside air louvers, hoods, filters, roof curbs, structural framing, roof construction, roofing, and the work of all trades to insure an orderly and timely progression of the work.

1.5 SHOP DRAWINGS

A. Include complete data on: access doors; flexible connectors; manual volume dampers including operating hardware; extractors; turning vanes; automatic shutters and all other items.

B. See section entitled, "General Mechanical Provisions".

1.6 OTHER REQUIREMENTS

A. Provide all components in accordance with manufacturer's recommendations.

B. All ductwork dimensions indicated which may affect items of this section are nominal free clearance internal dimensions which do not include insulation thickness.

1.7 DEFINITIONS

A. "SMACNA" means "Sheet Metal and Air Conditioning Contractors National Association, Inc.".

PART 2 - PRODUCTS

2.1 GENERAL

A. Be recommended by the manufacturer for the application.

B. Products listed in this Section or on the plans are based on a specific manufacturer to establish the desired style, quality and type. Equivalent products, complying with the requirements of this Section and the installation requirements of the plans, by the following manufacturers are acceptable:

1. Ventfabrics
2. Barber-Colman
3. Tuttle & Bailey
4. Dura-Dyne
5. Airsan
6. Titus
7. Anemostat
8. Young Regulator.
9. Metalaire
10. United McGill

C. Products which are specified may not necessarily all be required on the projects; provide those products which are applicable.

2.2 FLEXIBLE DUCT CONNECTIONS

A. Provided where air handlers, fans and blowers connect to their ductwork.

B. At least 4 inches long.

C. Connected on each side to metal (either metal ductwork, air handling apparatus, or heavy gauge steel sleeves).

D. For use in high and/or low pressure duct systems.

E. Ventfabrics, Inc., "Ventglas Metaledge", or equivalent.

2.3 SPLITTERS

A. Provide for adjustment of air volume to their respective branches, where indicated. Constructed of at least the same gauge galvanized steel as the duct wherein they are used, and in no instance be less than twenty-two (22) US gauge. Use in low pressure duct systems only. Be adequately sized to close off air to applicable branches. Rigidly attached to pivot rod and operating linkage. Install on raised insulated base when used in internally insulated ductwork. Splitter blades; formed in two thicknesses of metal so that entering edge presents rounded nose to air flow; length no less than one and one half times the width of the smaller branch served or twelve inches, whichever is larger. Hardware used for the construction, assembly, and operation of splitter dampers shall be as follows:

1. Operators for exposed splitters and those located above "lay-in" or accessible ceiling shall be Ventlok #690 splitter damper assembly.
2. Operators for concealed splitters shall be Ventlok #691 with #680 miter and #677 concealed regulator.

2.4 LOW PRESSURE METAL TURNING VANES

A. Provide in all elbows, bends and tees of all low velocity supply air ducts whether or not shown in detail; provide in all elbows, bends and tees of all other low velocity ducts where portions of such ducts convey air at greater than 700 fpm average velocity. Adequate rigidity and strength to be completely flutterproof; properly designed; permanently fixed type. Aluminum, or steel with acid/solvent chemical corrosion resistant coating, or galvanized steel. Air foil type in all mitered elbows, mitered bends and tees. Air foil type must be manufactured by Titus, Tuttle & Bailey, Anemostat, Waterloo, Metalaire, Barber-Colman or other approved manufacturer. Be Barber-Colman "Airturns", Tuttle and Bailey "Ducturns", or Dura-Dyne "VR" with 24 gauge rails and hollow vanes, or equivalent.

2.5 HIGH PRESSURE TURNING VANES

A. Provide high pressure turning vanes in elbows, bends and tees of high pressure systems. Material and installation shall be in accordance with SMACNA Standards.

2.6 EXTRACTORS

A. Provide at rectangular branch duct take-offs.

B. Use in low pressure duct systems only.

C. Properly designed to deflect, proportion and direct the indicated air quantities to the branch duct and/or to the registers, grilles or other outlets without causing objectionable noise or pressure drop.

D. Multi-vaned and adjustable.

E. Aluminum, or steel with acid/solvent chemical corrosion resistant coating, or galvanized steel.

F. Provided with devices for adjusting and securing the position of these deflectors; these devices shall allow adjustment of the deflectors from outside the completed ductwork without necessity for puncturing or otherwise penetrating ductwork and/or its vapor barrier.

G. Made by Titus, Tuttle and Bailey, Metalaire, Anemostat, Waterloo, Barber-Colman, or equivalent.

H. Be similar to Titus Model AG-45 or AG-225 Volume Extractor, Tuttle & Bailey Type VCL or VLK Vectrol, Waterloo Type DTM or DT2M Extractor, Anemostat "DTB" or "DTA" or Young Regulator "890" or 890A", or equivalent.

2.7 MANUAL VOLUME DAMPERS

A. These dampers are to be other than those specified as being integral with each register, diffuser and other air outlet or inlet.

B. Provided where indicated in the complete air distribution system(s) (including ductwork, return air plenums, etc.) to allow complete balancing of the air supply, return, ventilation and exhaust system(s).

C. Opposed blade type.

D. 8" maximum blade width.

E. Made of galvanized steel, stainless steel with acid/solvent chemical resistant coating (for fume hood exhaust systems), or steel with a sprayed or dipped aluminum rust resistant finish; flutterproof.

F. Provided so that all damper adjustment can be made from outside the completed ductwork without necessity for puncturing or otherwise penetrating the ductwork and/or its vapor barrier.

G. Fully adjustable and with locking device.

H. Manufactured by Titus, Tuttle & Bailey, Anemostat, Waterloo, Metalaire, Greenheck or equivalent.

I. Provided at a point in the ductwork which is a sufficient distance upstream from an outlet (or downstream from an inlet) to attenuate objectionable noise due to damper throttling and to preclude adverse effects on the distribution device.

J. Based upon location of the duct in which the damper is to be installed, provide the following types:

1. Dampers in ducts which are exposed or located above "lay-in" or "accessible ceilings": Young Regulator Company Model 817 or equivalent.
2. *Dampers in brank ducts serving more than one diffuser register or grille and concealed above drywall ceilings or behind dry wall construction: Young Regulator Company Model 1200-301-FS Worm Gear Flex Shaft Assembly for rectangular or round ductwork as applicable. Termination shall be a chrome cover plate. Provide the cable length required for each damper. This requirement includes branch ducts in the locker rooms and toilet rooms with hard ceilings. Damper shall be by Young Regulator.*

K. Use in low pressure duct system only.

2.8 LOW PRESSURE DUCT ACCESS DOORS

A. Provided for: each manual and motorized damper; fire damper; smoke damper; electric duct heater; and where access is otherwise necessary.

B. Factory prefabricated double wall insulated type of 24 US gauge galvanized steel (of same or thicker gauge than ductwork panel in which installed, whichever is greater).

C. Minimum size shall be as large as is compatible with duct size but in no case less than the following (provide larger sizes if necessary to permit proper access operation):

Max. Duct Dimensions	Access Door Size
11" and less	10" x 12"
12" through 16"	12" x 16"
17" and over	16" x 24"

D. Doors shall be provided with and operated adjustable tension catches and shall be completely gasketed around their perimeters. Doors shall be Ventlok "Access Doors". Install in accordance with manufacturers recommendations using Ventlok #360 sealant or equivalent.

2.9 TEST OPENINGS

A. Furnish and install gasketed capped test openings for test equipment (pitot tubes, etc.) on the entering and leaving sides of air handling unit and other air handling equipment and heating coils. Test openings shall be Ventlok #699-2 or equivalent.

2.10 PREFABRICATED DUCT CONNECTIONS

A. At Contractor's option, prefabricated duct connections as manufactured by Ductmate (or approved equal system) may be used in locations and applications for which the duct connection system is recommended. Use of these connections must meet or exceed specified duct construction quality as related to structural rigidity, pressure, accessibility and other such requirements.

PART 3 – EXECUTION

3.1 GENERAL

A. Construct and install all accessories in accordance with the latest indicated editions of applicable SMACNA construction standards.

B. Provide all mitered elbows with turning vanes.

C. Install all duct system accessories in accordance with manufacturer’s recommendations.

D. All accessories installed in double-walled ductwork shall match the material and insulation requirements for double-walled ductwork.

E. Install cable-operated dampers that will be installed above hard ceilings prior to installation of any ceiling framing systems, etc. All cable operated dampers shall be clearly indicated in the duct shop drawing phase.

END OF SECTION 23 33 00

SECTION 23 33 14
DAMPERS: FIRE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. All work of this section shall be governed by all provisions of the general, supplementary and special conditions of these specifications and the drawings.

B. Take adequate precautions to insure that installed dampers/operators are protected from damage during construction.

1.3 RELATION TO OTHER WORK

A. Refer to the section "General Mechanical Provisions" for related requirements. Refer to other sections of Division 23 and to all other applicable portions of the drawings and specifications.

PART 2 - PRODUCTS

2.1 GENERAL

A. Fire dampers shall comply with Underwriters Laboratories (UL) Standard 555 and bear the UL test label.

B. The sheet metal installer, in conjunction with the metal stud installer and drywall installer, shall fabricate a mock-up of each type of fire damper installation in a one-hour fire wall. The mock-ups shall contain all required framing, retaining angles, sleeves, caulking, drywall and other appurtenances as shown on the details and/or the manufacturer’s installation instructions. After fabrication the mock-ups shall be approved by the Architect/Engineer. The mock-ups shall remain on the project premises to be used for reference and training purposes.

C. Provide dampers which are to be installed in a horizontal plane with spring closing mechanisms.

2.2 CURTAIN TYPE FIRE DAMPERS

A. Provide curtain type spring-driven UL 555 tested fire dampers in types and sizes indicated, with casing constructed of 20 gauge galvanized steel fusible link 160-165^{o}F (71-74^{o}C), unless otherwise indicated, and matching factory-furnished installation sleeve with integral access door. All Fire dampers shall be selected for duct size, opening, orientation and wall rating.

B. Acceptable manufacturers are: Ruskin Model DIBD2; Greenheck.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide access doors to facilitate relinking of fire and fire/smoke dampers.

B. See installation details on plans.

C. Adhere strictly to damper manufacturer's instructions.

D. Install multi-blade type fire dampers in ducts at grilles and registers if and where indicated on drawings.

E. Install curtain type fire dampers in all ducts penetrating fire-rated walls/partitions rated less than 3 hours. Manufacturer’s representative shall verify all quantities and sizes during bidding.

END OF SECTION 23 33 14

SECTION 23 34 25
FANS: IN-LINE CENTRIFUGAL, LIGHT DUTY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Provide in-line centrifugal light duty exhaust fans of size, sound power level, and electrical characteristics indicated on drawings.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 23 and to all other applicable portions of the Drawings and Specifications.

1.4 SHOP DRAWINGS

A. Refer to requirements of Section entitled "General Mechanical Provisions". Include complete data on: fan external static pressure, fan rpm, motor rpm, fan tip speed, fan size, fan performance tables or curves showing all possible operating selection points for each fan size (including rating certification), fan brake horsepower, motor horsepower and electrical characteristics sound level, fan accessories, and a complete schedule worked up by fan number.

B. Exhaust air fans shall be AMCA certified as to both sound and performance ratings.

1.5 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, “Methods for Calculating Fan Sound Ratings from Laboratory Test Data.” Factory test fans according to AMCA 300, “Reverberant Room Method for Sound Testing of Fans.” Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, “Laboratory Methods of Testing Fans for Rating.”

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Division 23 Section “Identification of Piping Systems, Ductwork and Equipment”.

1.6 MANUFACTURER

A. Products listed in this Section or on the plans are based on a specific manufacturer to establish the desired style, quality and type. Equivalent products, complying with the requirements of this Section and the installation requirements of the plans, by the following manufacturers are acceptable:

1. Greenheck Fan and Ventilator Corp. *(Basis of Design).*
2. Loren Cook.
3. Penn Barry.

PART 2 - PRODUCTS

2.1 FAN HOUSING

A. Fan housing including longitudinal, traverse, and diagonal stiffeners, motor mounts, bearing and drive supports shall be constructed of steel. Entire fan housing shall be internally lined with 1/2-inch or greater, three pound per cubic foot density fiberglass acoustical duct liner with a stabilized surface. Liner shall be held in place with adhesive and mechanical fasteners. All insulation and adhesives shall meet requirements of NFPA 90A as to flame spread and smoke developed ratings. Housing, including all bracing, stiffeners and motor mounting assembly shall be factory finished with a baked on alkyd enamel finish over a corrosion resistant primer. Removable panels in bottom and sides of housing for complete access to motor and fan. Inlet and outlet duct connection collars.

2.2 FAN WHEEL

A. Shall be centrifugal type and shall be statically and dynamically balanced.

2.3 FAN MOTOR

A. Permanently lubricated shaded pole motor mounted on resilient isolators to minimize vibration and noise.

2.4 BACKDRAFT DAMPER

A. Mounted in throat of fan discharge.

2.5 DRIVE ASSEMBLY

A. Drive shall be belt or direct drive type as indicated on drawings, and shall conform with the requirements of Section entitled "General Mechanical Provisions".

2.6 DISCONNECT SWITCH

A. Fans shall include factory mounted disconnect switches prewired to the drive motor.

2.7 SPEED CONTROL

A. Solid state speed controller for speed reduction to 40%. Mounted on housing or as otherwise indicated.

PART 3 – EXECUTION

3.1 FAN PLACEMENT AND MOUNTING

A. Fan locations shall be essentially as shown on drawings; however, actual wall openings and fan placement shall be verified using field measurements and data relating to equipment approved for actual installation on this project. Mount fan in strict accordance with manufacturer's instructions.

3.2 SOUND AND VIBRATION CONTROL

A. Refer to Section entitled "Ductwork" for air side sound control and to Section entitled "Vibration Isolation" for vibration control.

3.3 DUCT CONNECTIONS

A. Inlet and discharge ducts shall be connected to the fan duct collars using flexible connectors. These connectors shall be installed properly so that they are not in tension and are aligned with their respective ducts.

3.4 TEST AND BALANCE

A. All fan performance shall be certified as specified in section describing test and balance procedures.

3.5 OTHER REQUIREMENTS

A. Remove shipping bolts and temporary supports within fans. Adjust dampers for free operation.

B. Provide necessary anchorage and supports to prevent vibration.

C. Provide Kevlar belts for belt drive fans.

D. Provide accessible grease ports.

END OF SECTION 23 34 25

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 34 26
FANS: PROPELLER, WALL MOUNTED

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, general and special provisions of the Contract, including General and Supplementary Conditions, Division-01 Specification sections and Special Provisions, apply to this section.

1.2 SCOPE

A. Provide propeller type wall mounted fans in direct drive, belt drive or heavy duty types of size, capacity, sound power level and electrical characteristics indicated and scheduled on the drawings.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 23 and to all other applicable portions of the Drawings and Specifications.

1.4 SHOP DRAWINGS

A. Refer to requirements of Section entitled "General Mechanical Provisions". Include complete data on: fan external static pressure, fan rpm, motor rpm, fan tip speed, fan size, fan performance tables or curves showing all possible operating section points for each fan size (including rating certification), fan brake horsepower, motor horsepower and electrical characteristics, sound level, fan accessories. Data shall take form of engineering data sheets, clearly depicting specifications compliance, and a complete schedule worked up by fan number.

1.5 CERTIFIED PERFORMANCE

A. Exhaust fans shall be AMCA certified as to performance ratings.

1.6 MANUFACTURER

A. Products listed in this Section or on the plans are based on a specific manufacturer to establish the desired style, quality and type. Equivalent products, complying with the requirements of this Section and the installation requirements of the plans, by the following manufacturers are acceptable:

1. Greenheck Fan and Ventilator Corp. (Basis of Design- Model numbers as scheduled)
2. Penn Ventilator Company.
3. Loren Cook Company

PART 2 - PRODUCTS

2.1 GENERAL

A. Frame and Wall Plate: The entire structural frame, motor mounting plate, drive and bearing support and wall plate shall be constructed of heavy gauge steel coated with iron phosphate and finished with baked alkyd enamel or coated with acrylic epoxy. Wall plate shall incorporate a deep section bell mouth fan orifice.

B. Fan Wheel: Propeller type.

C. OSHA Safety Guards: Frames shall be expanded metal screen safety guards in structural steel frames to completely enclose the motor and drive side of the fan. Comply with OSHA requirements.

D. Wall Housings: Constructed of heavy gauge galvanized steel and provided with flanges for mounting and for easy attachment of fan guards and gravity automatic backdraft damper. Provide wall housings for all propeller fans.

E. Coatings: Provide protective baked phenolic coating for all propeller fan components and accessories including, but not limited to, the OSHA safety guard, wall housing, fan housing and blade assemblies for seacoast applications.

2.2 WALL TYPE PROPELLER FANS, DIRECT DRIVE

A. Fan Wheel: Aluminum blades or heavy gauge reinforced steel blades fastened to steel hub. Wheel shall be securely locked to solid steel shaft. Non-overloading type.

B. Drive Assembly: Motor and drive assembly for units with wheels 21" diameter and larger shall be mounted on rails. Fan motor bearings shall be permanently lubricated sealed ball bearings. Drives shall be direct driven.

PART 3 - EXECUTION

3.1 FAN PLACEMENT AND MOUNTING

A. The fan locations shall be essentially as shown in the drawings; however, actual wall openings and fan placement shall be verified using field measurements and data relating to equipment approved for actual installation on this project. Mount fan in strict accordance with manufacturer's instructions. Fan housing shall connect to a fixed exhaust louver installed in the exterior building wall.

3.2 WIRING

A. Connections between disconnect switches, variable frequency drives and fan motors shall be made so as not to interfere with blade rotation, shutter operation, removal of fan guards or otherwise inhibit access to the fan and its drive assembly.

3.3 TEST AND BALANCE

A. All fan performance shall be certified as specified in section describing test and balance procedures.

3.4 OTHER REQUIREMENTS

A. Remove shipping bolts and temporary supports within fans. Adjust automatic shutters for free operation.

B. Furnish to Owner, with receipt, one spare set of belts for each belt drive fan.

C. Provide necessary anchorage and supports to prevent vibration.

END OF SECTION 23 34 26

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 34 27
COMMERCIAL/INDUSTRIAL HVLS CEILING FANS

PART 1 - GENERAL

1.1 SUMMARY

A. High Volume, Low Speed (HVLS) fans shall create large air movement. They shall utilize a D-Drive DC motor that eliminates the need for a gearbox, which reduces noise and moving parts. Fan shall include an on-board processor that integrates into building operating systems via gateway and automatically adapts to input voltages.

1.2 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used shall include:

1. Preparation instructions and recommendations
2. Storage and handling requirements and recommendations
3. Power wiring, DDC interface, Fire Alarm interface and mounting requirements.
4. Application Drawings: Submit plan, section, elevation and isometric views as necessary to convey the information required to detail all installation conditions for each unit specified.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: manufacturer shall provide sole source for design, engineering, manufacturing and warranty claims handling.

B. Installer Qualifications: Any and all work outside the scope of the installation guide shall be outsourced. Factory trained installers are recommended and available upon request.

1.4 REFERENCES

A. Underwriters Laboratories (UL 507).

1.5 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity and ventilation) within limits recommended by manufacturer for optimal results. Do not install products in environmental conditions outside manufacturer's absolute limits. The storage of all products prior to installation will be in an "out of weather" position. Failure to maintain the integrity of the shipment is not the responsibility of the equipment manufacturer.

1.6 COORDINATION

A. The fan(s) shall be capable of receiving a stop command from the fire panel, an ASD (Aspirating Smoke Detection) device, or any number of smoke, flame or heat detectors.

B. The fans shall be as follows:

1. The fan shall meet the air velocity requirements of FM Global's 2.0 data sheet for ESFR sprinklers.
2. If required by the local fire prevention authority or desired by the purchaser, the fan shall be wired into the building's fire suppression system so that the fan will automatically shut off within a maximum of 90 seconds after sprinklers are activated. To facilitate this automatic shut-down, the low voltage wire and relay needed to accomplish this must be supplied by the Fire Alarm installer. See Manufactures installation instructions for further details.
3. Upon fire detection as described above, the fans shall coast to stop as required by NFPA guidelines.

1.7 WARRANTY

A. Manufacturer shall repair or replace warranted defective parts as follows:

1. Lifetime warranty on hub, airfoils and mounting.
2. Motor, Drive and Controller: 10-years.
3. Labor: 2-years.

B. At project closeout, provide to Owner or Owner's Representative an executed copy of the manufacturer's standard limited warranty against manufacturing defect, outlining its terms, conditions and exclusions from coverage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design: Big Ass Fans; Powerfoil Model PFD1-0522; 8 foot diameter.

B. Other Acceptable Manufacturers:

1. MacroAir Technologies, Inc.

C. Substitutions: Not permitted other than those listed.

2.2 COMMERCIAL/INDUSTRIAL HVLS FANS

A. Performance: The fan shall be listed to applicable UL Standards and requirements by UL.

B. Airfoils: The fan shall be equipped with six (6) airfoils. The airfoils shall consist of anodized 6061 T4 precision extruded aluminum, with fan diameters ranging from 8 to 18 feet in two (2) foot increment. The airfoils shall be connected to six (6) individual aluminum 6005 T6 struts by means of two (2) 5/16-24 x 2-inch grade 5 hex bolts, two (2) 5/16-inch flat washers and two (2) 5/16-inch nylon lock nuts per airfoil.

1. Number of Airfoils: 6
2. Airfoil Material: 6061 T4 Extruded Aluminum
3. Airfoil Finish: Anodized.
4. Option Airfoil Finish: Custom powder coated colors per Drylac RAL color chart

C. Motor: The fan shall be equipped with a Transverse Flux brushless DC motor designed for low speed high torque applications. The motor shall be driven sensorlessly to eliminate the possibility of sensor or encoder failure.

1. Motor Type: Sensor-less Transverse Flux brushless DC Motor
2. Continuous Torque: 52 lbf (70 Nm)
3. Pole Count: 96
4. IP Rating: 65
5. Insulation Class: K (200 C)
6. Motor Finish and Color: Black Electrophoretic Paint
7. Motor Housing: AISI 383 (ADC12)
8. Studs: AISI 4137 Grade 9 (JIS SCM435)

D. Integrated Drive (Refer to the Fan Schedule).

1. Electrical Requirements (Low Voltage):

   a. 104-277 VAC single (1) phase 50/60 Hz, or
   b. 181-255 VAC three (3) phase 50/60 Hz

2. Electrical Requirements (High Voltage):

   a. 241-294 VAC one (1) phase 50/60 Hz, or
   b. 342-636 VAC three (3) phase 50/60Hz.

3. Environment:

   a. Operation: -10ºC to 60ºC
   b. Humidity: 0-95% non-condensing
   c. Cooling: Centrifugal cooling through blades.

4. Operating Frequency: 20-50 KHz.
5. Firmware Updates: Via RJ45 (Remote) connector.
6. Dynamic acceleration and deceleration.
7. Modbus 485 (19.2 8-N-1).
8. BACnet (MSTP) option for DDC Control Interface.
9. Recessed Network LED Color Touch-Screen to Control all ceiling fans with:

   a. Live fault code monitor.
   b. Live fan speed monitor.
   c. Impact and solvent resistant.
   d. IP65 rated.
   e. CAT 5e Cabling included (up to 400 Feet).
   f. Fire Alarm Control Panel interface. Wired normally open or closed in the field.
   g. Bacnet interface.

E. Mounting: The fan mounting system shall be equipped with hardware, no less than SAE grade 5 for safe installation. The fan shall be equipped with a stress reliving swivel (SRS) mount. The fan mount shall encompass multiple mounting options for I-beam, Purlin and Glulam applications (specified upon order).

1. Standard Mount: SRS I-beam clamp with 3’ drop
2. Optional Mounting Hardware: UMH with Guy Wires
3. Mounting Drops: Extensions available in two (2) to ten (10) foot lengths in one (1) foot increments (custom sizes available)
4. Mounting and Extension Material: Steel, Aluminum.

5. Mount Finish: Black Anodized.

F. Hub/Motor Housing: The fan shall be equipped with an aluminum motor housing with pressed in steel studs to securely accept six (6) removable, black anodized, 6005 T6 aluminum beam struts. The struts shall be designed with airfoil guides to ensure precision alignment.

1. Material: T6 Cast Aluminum.
2. Airfoil Strut Material: 6005 T6 Aluminum.
3. Airfoil Strut Finish: Black Anodized.
4. Hardware: Twelve (12) 5/16-24 x 1-3/4 inch Grade-8 pressed in studs.
5. Hardware: Twelve (12) 5/16-inch flat washers (SAE).
6. Hardware: Twelve (12) 5/16-inch nylon lock nuts.

G. Safety System: The fan shall include one-piece airfoil retainer links to prevent airfoil separation from the motor housing and a 3/16” safety cable attached to the lowest point of the fan. Each fan shall be E-stop compatible for fire and building automated systems (BAS).

1. Safety Cable Material: 3/16” x 7 x 19 Braided Steel.
2. Safety Cable Finish: Galvanized.
3. Airfoil Retainer Link Material: 10 Gauge A36 Steel.
4. Airfoil Retainer Link Finish: Black Zinc.

PART 3 - EXECUTION

3.1 PREPARATION

A. Check accuracy of dimensions indicated for openings to receive fans.

B. Check location and availability of utility services to ensure proper voltage and installation preparation.

C. Coordinate location and installation of the HVLS Fans.

D. Ensure building structural members are sufficient to support the weight and operation of the fan. Consult professional engineer or registered architect as required.

3.2 INSTALLATION

A. Install units per manufacturer's written instructions.

B. Fan airfoil height to be a minimum of 10 feet from the floor in accordance with manufacturer’s recommendations.

C. All safety and support features must be installed. These include any guy wires and safety cables as well as airfoil retainer locking features.

D. Adjust unit as required for proper operation in accordance with manufacturer’s installation instructions.

E. Securely anchor units.

F. Ensure that operating parts turn freely prior to initial startup.

G. Repair or replace damaged parts, dents, buckles, abrasions or other damage affecting appearance or serviceability, as acceptable to Architect.

3.3 PROTECTION

A. Protect finished Work until date of Substantial Completion.

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

3.4 CLEANING

A. Clean Work per Section 01 74 00.

B. Clean and inspect fans per manufacturer's instructions.

C. Remove temporary protective cover at date of Substantial Completion.

END OF SECTION 23 34 27

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 36 16
TERMINAL UNITS: VAV, SINGLE INLET, ELECTRIC COIL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Provide single inlet, variable air volume (VAV) terminal units of types, sizes and capacities indicated.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 23 and to all other applicable portions of the Drawings and Specifications.

1.4 SHOP DRAWINGS

A. Refer to Section entitled "General Mechanical Provisions". Include: complete performance data at the scheduled operating conditions; dimensions; performance data; pressure loses; descriptions; discharge and radiated sound power levels at the stated conditions.

1.5 MANUFACTURER

A. Products listed in this Section or on the plans are based on a specific manufacturer to establish the desired style, quality and type. Equivalent products, complying with the requirements of this Section and the installation requirements of the plans, by the following manufacturers are acceptable:

1. Trane.
2. Titus.
3. Krueger.
4. Metallaire.
5. Price.

1.6 TERMINOLOGY

A. The word "box" or "terminal unit" used throughout this section without any modifying adjective shall mean the entire terminal unit assembly including all other accessories integral therewith, unless otherwise indicated. Terminal units may be referred to as "TU".

1.7 NOISE CRITERIA

A. Unless otherwise indicated on drawings, the following noise criteria comprise the basis upon which the selected terminal units must be rated in order to comply with the design limits for allowable NC levels:

1. All sound power level decibels are referenced to 10 to the minus 12 watts.
2. Room outlet NC sound pressure levels specified for these TUs are based on 10db room absorption.
3. Room radiated NC sound pressure levels specified for these TUs are based on 10db room absorption plus 13 NC ceiling sound transmission loss.
4. *The maximum allowable NC level in any occupied space (unless otherwise indicated) shall not exceed NC20 as a result of radiated or discharge noise from any terminal unit.*
5. NC levels which are generated by the terminal units on which noise criteria will be judged are those NC levels generated when the terminal unit is operating with an inlet static pressure of 1.0-inch w.g.

1.8 SELECTION

A. Terminal units shall be selected for maximum air discharge within the mid-range of the TU rating so that field adjustment of maximum indicated discharge air quantity may be made plus and minus 15%.

1.9 LEAKAGE

A. Terminal units intended for full shut-off operation shall not have air leakage of more than 2% of nominal box capacity when inlet pressure is 6.0 inches w.g.

1.10 PRESSURE DROP

A. Maximum allowable static pressure drop across the control box portion of any terminal unit (i.e., excluding any applicable companion sound attenuator or heating coil) shall not exceed 0.20 inches w.g. or the value(s) scheduled on drawings. Maximum allowable minimum operating pressure of the entire unit shall not exceed 0.50 inches w.g.

PART 2 - PRODUCTS

2.1 TERMINAL UNITS

A. Control Unit: Double-wall, galvanized steel or aluminum casing; insulated between the outer and inner wall with 1-inch thick high density fiberglass insulation to prevent condensation (comply with NFPA 90A); acoustically treated to reduce noise level; air quantity indicator; access panel(s) for complete access to all parts of the assembly which may require service, maintenance and repair. The solid inner liner shall be constructed of 26-gage galvanized steel. DDC controllers shall be factory-mounted in each VAV terminal. Terminal manufacturer shall coordinate with the DDC Control Vendor (Siemens).

2.2 ELECTRIC HEATING COIL

A. General: Each terminal unit shall be provided with an integral, factory-mounted electric heating coil/control panel. Heating coils shall have all operating characteristics completely coordinated to function satisfactory as an integral part of the fan terminal unit. Capacities for each integral heater shall be as scheduled on the drawings. Provide integral disconnect on the door of the heating coil control panel.

B. Other Requirements:

1. Meet all applicable requirements of the current NEC.
2. UL listed including all built-in components.
3. Coordinated with the specified requirements of the mechanical system control system.
4. *Removal/Replacement of the heating coil shall be accomplished by removal of four screws. If other VAV manufacturer's can indicate that their VAV Electric coil can be removed in this manner they may be considered for use as an "Equal" manufacturer if all other specification requirements are met.*

C. Materials:

1. Open coil type.
2. Full fine break mercury contactors which will break all ungrounded conductors (note horizontal, vertical or oblique position of each heater assembly as shown on drawings).
3. Transformer with primary fusing if control voltage is different from supply voltage.
4. Over-current protection in accord with NEC requirements.
5. Control terminals and power terminals.
6. Built-in or remote pressure type air flow switch. Install in series with automatic reset thermal cutout.

D. Wiring Diagrams: Provide complete wiring diagram furnished by the heating coil system manufacturer to the mechanical systems control manufacturer and the Electrical Contractor. This wiring diagram shall completely indicate in full detail all electrical and control wiring requirements, terminal, etc. necessary to allow the control manufacturer and Electrical Contractor to completely coordinate their respective wiring portions of the heating coil system installation.

2.3 CONTROL REQUIREMENTS

A. Pressure Independent Operation: Terminal units must operate independent of inlet pressure fluctuations in the main or branch duct system. Units must have controls which are factory installed, factory calibrated and factory tested to be pressure-independent. This pressure-independent feature must be a standard catalogued feature or available and provided as a standard catalogued option.

1. Units shall maintain constant discharge flow for any given set-point with any variation in inlet static pressure between 0.2 inches w.g. and 6.0- inches w.g.
2. All terminal units must be factory set for design air flow and for minimum air flow.

B. Adjustment: Unit must have capability for easy field adjustment of maximum and minimum air quantities by resetting of control mechanism(s) on terminal unit.

C. Operation:

1. Discharge volume setting shall be controlled throughout indicated variable volume operating range as dictated by the controller which signals air flow requirements.

2. Controls integral with the terminal unit shall be provided by the terminal unit manufacturer. This includes damper motors and similar items.
3. Controls/Controllers must be completely compatible in all respects with the related components of the building temperature control system.

D. Refer to section describing control operation and to control diagrams for coordination.

E. Sensor: In addition to other requirements, the terminal unit shall have an inlet flow/pressure sensor which is designed to operate in conjunction with variable air volume exhaust hood control systems where applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate location with all ducts, beams, joists, conduit, lights, piping, air distribution devices and other items in immediate vicinity of indicated locations. Make minor adjustments in exact locations shown to best fit available space.

B. Make all duct connections to and from boxes in as streamlined a manner as practical so that air pressure drop is minimized. Make such connections air tight at operating pressures encountered. Coordinate exact box location and inlet duct connection so that any straight diameters of inlet duct are provided as may be required by the terminal unit manufacturer for proper operation.

C. Locate terminals so that access for repair, maintenance and adjustment is easily facilitated without removal of other permanently located items which are in the immediate vicinity of boxes (this excludes removable ceiling panels, removable air distribution devices attached to flexible ductwork and other similar items). *DO NOT INSTALL terminal units unless all clearance requirements are provided in the field.*

D. No terminal unit outlet (including companion sound attenuator, if needed) shall be nearer than 60-inches from the first flexible duct connection take-off to the first downstream air distribution device.

E. Coordinate controls to take into account revere or direct acting thermostats, whether TU’s are normally open or normally closed, and similar interfacing.

END OF SECTION 23 36 16

SECTION 23 36 17
TERMINAL UNITS: VAV, SINGLE INLET

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Provide single inlet, variable air volume (VAV) terminal units of types, sizes and capacities indicated.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 23 and to all other applicable portions of the Drawings and Specifications.

1.4 SHOP DRAWINGS

A. Refer to Section entitled "General Mechanical Provisions". Include: complete performance data at the scheduled operating conditions; dimensions; performance data; pressure loses; descriptions; discharge and radiated sound power levels at the stated conditions.

1.5 MANUFACTURER

A. Products listed in this Section or on the plans are based on a specific manufacturer to establish the desired style, quality and type. Equivalent products, complying with the requirements of this Section and the installation requirements of the plans, by the following manufacturers are acceptable:

1. Trane.
2. Titus.
3. Krueger.
4. Metallaire.
5. Price.

1.6 TERMINOLOGY

A. The word "box" or "terminal unit" used throughout this section without any modifying adjective shall mean the entire terminal unit assembly including all other accessories integral therewith, unless otherwise indicated. Terminal units may be referred to as "TU".

1.7 NOISE CRITERIA

A. Unless otherwise indicated on drawings, the following noise criteria comprise the basis upon which the selected terminal units must be rated in order to comply with the design limits for allowable NC levels:

1. All sound power level decibels are referenced to 10 to the minus 12 watts.
2. Room outlet NC sound pressure levels specified for these TUs are based on 10db room absorption.
3. Room radiated NC sound pressure levels specified for these TUs are based on 10db room absorption plus 13 NC ceiling sound transmission loss.
4. *The maximum allowable NC level in any occupied space (unless otherwise indicated) shall not exceed NC20 as a result of radiated or discharge noise from any terminal unit.*
5. NC levels which are generated by the terminal units on which noise criteria will be judged are those NC levels generated when the terminal unit is operating with an inlet static pressure of 1.0-inch w.g.

1.8 SELECTION

A. Terminal units shall be selected for maximum air discharge within the mid-range of the TU rating so that field adjustment of maximum indicated discharge air quantity may be made plus and minus 15%

1.9 LEAKAGE

A. Terminal units intended for full shut-off operation shall not have air leakage of more than 2% of nominal box capacity when inlet pressure is 6.0 inches w.g.

1.10 PRESSURE DROP

A. Maximum allowable static pressure drop across the control box portion of any terminal unit (i.e., excluding any applicable companion sound attenuator or heating coil) shall not exceed 0.30 inches w.g. or the value(s) scheduled on drawings. Maximum allowable minimum operating pressure of the entire unit shall not exceed 0.50 inches w.g.

PART 2 - PRODUCTS

2.1 TERMINAL UNITS

A. Control Unit: Double-wall, galvanized steel or aluminum casing; insulated between the outer and inner wall with 1-inch thick high density fiberglass insulation to prevent condensation (comply with NFPA 90A); acoustically treated to reduce noise level; air quantity indicator; access panel(s) for complete access to all parts of the assembly which may require service, maintenance and repair. The solid inner liner shall be constructed of 26-gage galvanized steel. DDC controllers shall be factory-mounted in each VAV terminal. Terminal manufacturer shall coordinate with The DDC Control Manufacturer (Siemens).

2.2 CONTROL REQUIREMENTS

A. Pressure Independent Operation: Terminal units must operate independent of inlet pressure fluctuations in the main or branch duct system. Units must have controls which are factory installed, factory calibrated and factory tested to be pressure-independent. This pressure-independent feature must be a standard catalogued feature or available and provided as a standard catalogued option.

1. Units shall maintain constant discharge flow for any given setpoint with any variation in inlet static pressure between 0.2 inches w.g. and 6.0- inches w.g.
2. All terminal units must be factory set for design air flow and for minimum air flow.

B. Adjustment: Unit must have capability for easy field adjustment of maximum and minimum air quantities by resetting of control mechanism(s) on terminal unit.

C. Operation:

1. Discharge volume setting shall be controlled throughout indicated variable volume operating range as dictated by the controller which signals air flow requirements.
2. Controls integral with the terminal unit shall be provided by the terminal unit manufacturer. This includes damper motors and similar items.
3. Controls must be completely compatible in all respects with the related components of the building temperature control system.

D. Refer to section describing control operation and to control diagrams for coordination.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate location with all ducts, beams, joists, conduit, lights, piping, air distribution devices and other items in immediate vicinity of indicated locations. Make minor adjustments in exact locations shown to best fit available space.

B. Make all duct connections to and from boxes in as streamlined a manner as practical so that air pressure drop is minimized. Make such connections air tight at operating pressures encountered. Coordinate exact box location and inlet duct connection so that any straight diameters of inlet duct are provided as may be required by the terminal unit manufacturer for proper operation.

C. Locate boxes so that access for repair, maintenance and adjustment is easily facilitated without removal of other permanently located items which are in the immediate vicinity of boxes (this excludes removable ceiling panels, removable air distribution devices attached to flexible ductwork and other similar items). *DO NOT INSTALL terminal units unless all clearance requirements are provided in the field.*

D. No terminal unit outlet (including companion sound attenuator, if needed) shall be nearer than 60-inches from the first flexible duct connection take-off to the first downstream air distribution device.

E. Coordinate controls to take into account reverse or direct acting thermostats, whether TUs are normally open or normally closed, and similar interfacing.

END OF SECTION 23 36 17

SECTION 23 37 13
AIR DISTRIBUTION DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Provide all air distribution devices as indicated on the drawings and as specified herein for a complete and operable system.

B. All air distribution devices shall be constructed of aluminum. Steel or aluminized steel is not acceptable.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 23 and to all other applicable portions of the Drawings and Specifications.

B. Coordinate with work of the ceiling, drywall and plastering trades as required to insure an orderly progression of work and a first class finished system with respect to placement, alignment, finish, general fit and absence of conflict with lighting systems and fire protection systems.

Insulate air distribution devices to prevent condensation formation.

1.4 DESIGN CONDITIONS

A. Acoustical: Noise produced at each diffuser, register, grille or other air distribution device shall not exceed a noise criteria level of NC 20 based on sound pressure levels in db re 0.002 microbars unless otherwise indicated. Coordinate air distribution devices, sound attenuation measures and equipment actually provided to insure that this design constraint is not exceeded by the system installed.

Exceptions: Any particular rooms or areas which are normally occupied by other than maintenance staff or service staff and which may be noted on the drawings as requiring lower NC criteria.

B. Pressure Drop: Pressure drop across any air distribution device shall not exceed 0.15 in wg static pressure unless otherwise indicated.

1.5 SHOP DRAWINGS

A. ALL AIR DISTRIBUTION DEVICES SHALL BE SUBMITTED IN A DETAILED AIR DEVICE SCHEDULE INDICATING THE SPECIFIC PERFOMANCE REQUIREMENTS FOR EACH AIR DEVICE. *NO EXCEPTIONS*. THE SCHEDULE SHALL INCLUDE THE DIMENSIONS, AIRFLOW, STATIC PRESSURE, NC LEVELS, AIR OUTLET VELOCITY AND ROOM LOCATION. This project requires careful selection of the devices and any additional required information required to confirm the device submitted is at the discretion of the Architect and Engineer.

B. Failure to comply with all items requested in paragraphs A and B above will be subject to immediate disapproval.

1.6 MANUFACTURER

A. Products listed in this Section or on the plans are based on a specific manufacturer to establish the desired style, quality and type. Equivalent products, complying with the requirements of this Section and the installation requirements of the plans, by the following manufacturers are acceptable:

1. Titus.
2. Metalaire.
3. Price.
4. Krueger.

B. Manufacturers must be members of the Air Distribution Council unless otherwise indicated.

1.7 OTHER REQUIREMENTS

A. All aluminum is to be extruded unless otherwise indicated.

B. Appearance: Each air distribution device which has a portion thereof (frame, core, etc.) exposed to view in the finished area shall have a factory applied finish which matches and is compatible with the color of the surrounding surface on which the device is installed. Colors must be approved by Architect prior to device fabrication.

C. All louvers, dampers and/or shutters shall be rated by their manufacturer in accord with AMCA Standard 500-74.

D. Integral Components: All dampers, blank-off baffles and other companion devices which form an integral part of air distribution device shall be factory made items produced by the manufacturer of air distribution device.

E. Louvers: Louvers may be specified in another division but for reference may also be indicated on mechanical drawings.

F. Door Grilles: Door grilles may be specified in another division but for reference may also be indicated on mechanical drawings.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide the following air distribution devices as applicable to this project. Refer to air distribution device schedule as shown on drawings.

2.2 OTHER REQUIREMENTS

A. All devices must each comply with the applicable portions of the Air Diffusion Council (ADC) Equipment Test Code 1062R4 "Certification, Rating and Test Manual", the Air Movement and Control Association, Inc. (AMCA) Standard 500 "Test Method for Louvers, Dampers and Shutters" and the "National Fire Protection Association" (NFPA) Standard 90A "Installation of Air Conditioning and Ventilating Systems".

B. Provide ceiling and/or linear diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of diffuser.

C. Diffusers, grilles and registers installed in fire rated ceiling, or floor/ceiling assemblies shall be constructed of steel.

D. DRG’s installed in hard ceilings: Provide optional Aluminum Hard Ceiling Frame and Square/Rectangular face-operated dampers in each DRG to permit balancing of each device. Damper shall be selected to match-up with the DRG scheduled.

E. Mounting Screws: Where grilles, diffusers or registers are specified which require mounting screws visible from the face of the device these screws shall be furnished with the air distribution equipment and be finished at the factory to match the finish on the grille, diffuser or register in which they are to be used.

PART 3 - EXECUTION

3.1 GENERAL

A. Location: Install air distribution devices where indicated and in accordance with manufacturer's recommendations. The location of ceiling supply, return and exhaust air devices as shown on the architectural reflected ceiling drawings shall take precedence over any other location shown.

B. Exposed Duct and Device Interiors: Duct interiors, air distribution device interiors and blank-offs shall be painted with flat black enamel to eliminate light reflectance from the inside of the duct system.

C. Support: All ducts connected to air distribution devices shall be supported independently of the ceiling. Verify the ceiling grid type being furnished. Lay-in devices shall be supported from the structure above if the suspended ceiling grid is not designed to carry the weight of the device.

D. Surface Mounted Devices; Lay-In Ceiling: Unless otherwise indicated, locate units in center of acoustical ceiling modules.

E. Paint the interior of all return air grille plenum boxes flat black.

3.2 INSTALLATION

A. Rectangular Diffusers: Where diffusers are the lay-in type, they shall be supported by the inverted T-bar suspension system but all ducts connected thereto shall be supported independently of the ceiling as specified under Section entitled "Ductwork". Surface mounted diffusers shall be supported by the duct runouts or drops where sheet metal ducts are indicated and by separate hangers where flex runouts are indicated. All rectangular ceiling diffusers shall be installed with their lines parallel and perpendicular to the building line and properly aligned with the ceiling.

B. Sidewall Grilles and Registers: Mount securely to the duct system flanges using finish screws and in accordance with accepted good practice.

C. Ceiling mounted Exhaust and Return Registers/Grilles: Mount as specified hereinbefore for surface mounted ceiling diffusers except use finished screws provided and secure to duct and finished ceiling (or finished ceiling for non-ducted returns) in accordance with the manufacturer's instructions. Where required to provide adequate support for non-ducted registers or grilles, provide appropriate mounting frame for incorporation into the ceiling system.

D. Install all outlets and inlets as recommended by the manufacturer; in accordance with recognized industry practices; to insure that products serve intended functions.

E. Locate ceiling air outlets and inlets as indicated on the drawings. Unless otherwise indicated, locate units in center of acoustical ceiling modules. Install square and parallel with partitions, ceiling grid members, etc.

F. Spare Parts: Furnish to Owner, with receipt, 3 operating keys for each type of outlet and inlet that require them.

G. Do not install blank-offs under continuous linear diffuser distribution plenums. Distribution plenums shall cover only active portion of the diffuser.

3.4 INSULATION

A. General: The exterior of all supply devices shall be insulated with a minimum of 3/4 inch elastomeric or 1 inch fiberglass blanket with vapor seal. The vapor seal shall extend to the edge of the device.

3.5 PROTECTION OF WORK UNTIL FINAL ACCEPTANCE

A. Coordinate the installation of the air distribution equipment with related work and finishing of adjacent surfaces to prevent damage to the devices or adjacent finishes. Protect the finish of all air distribution equipment until final acceptance. Replace or repair to the Architect's satisfaction any damaged equipment.

END OF SECTION 23 37 13

SECTION 23 37 25
LOUVERS

PART 1 - GENERAL

1.1 SCOPE

A. Provide complete HVAC functional louver assemblies as indicated on Drawings and in Specifications.

1.2 SHOP DRAWINGS

A. Refer to the section entitled "General Mechanical Provisions".

B. Submit custom-color matching (for Architect's Approval) for all louvers with the color selection options also available. Coordinate with the Architect for color-match requirements.

1.3 CERTIFICATION

A. All performance shall be certified by AMCA and bear the AMCA Certified Ratings Seal for Air Performance and Water Penetration in accord with AMCA Standard 540 and 550.

B. All louvers shall meet the Miami-Dade protocol for wind-driven rain resistant louvers.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Stationary type; extruded aluminum construction.

B. All components factory assembled by the louver manufacturer including heads, jambs, sills, blades and mullions. Louver sizes too large for shipping shall be assembled at the site from factory assembled louver sections to provide the overall sizes required.

C. Frame:

1. 6-inch depth.
2. Suitable for mounting in the type of wall where indicated. Coordinate final frame selection with Architect and with wall construction indicated on architectural drawings.
3. Heavy gauge, extruded 6060-T5 aluminum of 0.081-inches nominal wall thickness.

D. Blades:

1. Horizontal, rain resistant style, heavy gage aluminum. Drainable type with drain gutter in each blade and downspouts in jambs and mullions.
2. Extruded aluminum of 0.081-inch minimum thickness.
3. Approximately 37-1/2-degree blade angle.
4. Blades on approximately 2-inch centers.

E. Finish:

1. Provide custom anodized aluminum color selections/color match for Architect's Selection and Approval. All selected finishes shall be factory-applied. No field painting will be accepted.

F. Operating characteristics:

1. High free area.
2. Low water penetration.
3. Free area based on air velocity of not greater than 500 fpm.
4. Air flow pressure drop in intake mode or exhaust mode of not greater than 0.025-inches w.g.s.p.

G. Design: Integral structural supports designed and furnished to withstand a wind load of not less than +160 lbs. PSF or -140 PSF.

H. Size: As scheduled or shown on Drawings or as required to comply with the above operating characteristic constraints.

I. Miami-Dade County Test Protocols Tested and Passed:

1. TAS 201-94 Large Missile Impact Test.
2. TAS 202-94 Uniform Pressure Test (for +140 psf).
3. TAS 203-94 Cyclic Wind Pressure Test.
4. TAS 100A Wind-Driven Resistance Test.

2.2 ACCESSORIES

A. Bird screen: Aluminum, 3/4-inch x 0.051 inch flattened, expanded aluminum in removable frame, inside mount (rear); typical for all louvers.

B. Frame: Perimeter Flange, 1-1/2-inch nominal width for louvers.

C. Insulated blank-off panels. Provide where un-used portions of the louver are indicated or required. Coordinate with mechanical contractor.

2.3 ACCEPTABLE MANUFACTURERS

A. Ruskin: Model No. HZ580 (Basis of Design).

B. Pottorf: Model No. ECD-545-MD or EFJ-937-MD

C. Greenheck: Model No. EHH-601D.

PART 3 - EXECUTION

3.1 GENERAL

A. Install in accord with manufacturer's recommendations and in accord with applicable portions of current SMACNA guidelines.

B. Installation shall be watertight between complete circumference of frame and wall. Coordinate all rough-in sizes with the tilt wall construction prior to release of any louvers, no exceptions.

C. Coordinate complete installation with other work related to structure, wall construction, ductwork (if any) and other such interfaces.

D. For additional requirements, refer to Architectural drawings, structural drawings and other portions of the Contract Documents.

END OF SECTION 23 37 25

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 41 00
AIR FILTER ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

A. Furnish and install complete air filter assemblies of the types, sizes and capacities indicated.

1.3 RELATION TO OTHER WORK

A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 23 and to all other applicable portions of the Drawings and Specifications.

1.4 SHOP DRAWINGS

A. Include complete performance data at the scheduled operating conditions; dimensions; weights; performance curves; airside pressure losses; quantities; descriptions; and any other necessary information.

PART 2 - PRODUCTS

2.1 GENERAL

A. Filters shall pass applicable air quantities at velocities and pressure drops which are within manufacturer's recommended operating ranges and as specified and scheduled.

B. Filter Manufacturers: Continental; American Air Filter; Cambridge; Farr; Flanders; Purafil; or equivalent.

C. Filter Housing Apparatus Manufacturers: Same manufacturer as the applicable filters or same manufacturer as the air handling unit in which installed, whichever manufacturer is applicable.

D. Air Handling Unit Filter Sections: Shall be of adequate size to accept specified filters. Air handling unit filter sections shall be factory made by air handling unit manufacturer or by filter manufacturer to be specifically compatible with applicable air handling unit.

2.2 PRE-FILTERS FOR AIR HANDLING UNITS

A. Filter Housing: Integral part of air handling unit assembly. (If not part of AHU assembly, provide external filter housing.)

B. Filters: Extended surface, pleated panel type; disposable; double-wall chipboard frame with diagonal support members; 2-inches thick; average efficiency no less than MERV 8 based on ASHRAE 52.2 test method; operate at an initial resistance of not more than 0.25-inches w.g.s.p. at 500 fpm face velocity.

C. Design base: Camfil Farr AeroPleat IV; MERV-8 High Capacity Pleated Panel Filter.

2.3 FINAL-FILTERS FOR AIR HANDLING UNITS

A. Filter Housing: Integral part of air handling unit assembly. (If not part of AHU assembly, provide external filter housing.)

B. Filter: Air filters shall be high performance, extended area, deep-pleated, 4-inch thick, disposable type. They shall consist of a filter element, media retainer holding frame and sealer frame. The media shall be a wet-laid microfine glass fiber which is reinforced by a laminated synthetic backing. The filter shall have an average efficiency of MERV 13 per on ASHRAE Test Standard 52.2. The filter shall be listed by Underwriters' Laboratories as UL 900-Class 2.

C. Design Base: Camfil Farr OptiPac; MERV-13, High-Efficiency.

2.4 FILTER ASSEMBLY FOR OUTSIDE AIR INTAKE TO AHU’s

A. Filter Housing: AAF/FLANDERS SurePleat model with gasketed side access doors on both sides of the unit.

B. Filters: Air filters shall be pleated, 2-inch thick, disposable type. The filter shall have an average efficiency of MERV 8 per on ASHRAE Test Standard 52.2. The filter shall be listed by Underwriters' Laboratories as UL 900-Class 2. Provide AAF/FLANDERS PREpleat LPD SC or approved equal.

C. Spare Media: provide 2 sets of spare filter media for each filter assembly.

PART 3 - EXECUTION

3.1 GENERAL

A. Arrangement and Access: Arrange, install and make provisions for easy access to and removal and replacement of filters. Provide access doors and/or panels as necessary.

B. Coordination and Matching: Coordinate assembly components and properly match sizes and quantities of filters with related air moving systems (e.g., air handling units, fan coil units, filter banks) so that filter assemblies will operate in accord with operating conditions, sizes and capacities as listed in this section or as otherwise indicated.

3.2 MISCELLANEOUS SUPPORT STEEL AND HARDWARE

A. Provide as required to provide for adequate support and structural integrity of each filter bank. In no case shall supplementary supports be less than those indicated or recommended by the filter manufacturer in his standard installation instructions.

3.3 FILTER ASSEMBLY LOCATIONS

A. Where scheduled and shown on the drawings.

3.4 ORIGINAL AND SPARE FILTER SETS

A. Provide an original filter set and two (2) spare filter sets for each unit having an air handling equipment filter assembly specified above. Upon initial start-up, each filter assembly shall be provided with a complete original filter set. Prior to or at the time of final test and balance, this original filter set shall be replaced with a complete new spare filter set. However, if at the time of final test and balance there is still useful operating life remaining in the initial filter set (i.e. the filters are still operating within their recommended pressure drop limits for the particular application), then the Contractor (if he is given written approval by the final test and balance agency) may give the spare filter sets to the Owner (at a place of the Owner's selection on the site) in lieu of replacing the original filters with the spare filters.

END OF SECTION 23 41 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 43 24
AIR PURIFICATION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This section describes the design, performance and installation of an air purification system intended for use as part of another manufacturer's air handling unit or mounted on the duct as shown on the plans, details and equipment schedules.

1.2 REFERENCED CODES AND STANDARDS

A. The following codes and standards are referenced throughout. The edition to be used is that currently enforced by the authority having jurisdiction (AHJ) or in absence of such direction that referenced by the current enforceable IBC code or as indicated by the contract documents, except where specifically referenced by this section of the specifications.

1. ASHRAE Standards 62 & 52
2. National Electric Code NFPA 70
3. UL 867

1.3 RELATED WORK

A. Testing, Adjusting and Balancing.

B. Ductwork.

C. Filters.

D. Water and Refrigerant Piping

E. Electrical Wiring.

F. Control Wiring.

1.4 QUALITY ASSURANCE

A. The Air Purification System shall be a product of an established manufacturer within the USA.

B. A qualified representative from the manufacturer shall be available to inspect the installation of the air purification system to ensure installation in accordance with manufacturer's recommendation.

C. Technologies that do not address gas disassociation such as UV Lights, Powered Particulate Filters and/or polarized media filters shall not be considered. Uni-polar ion generators shall not be acceptable. "Plasma" particulate filters shall not be acceptable.

D. Projects designed using ASHRAE Standard 62, IAQ Procedure shall require the manufacturer to provide Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1-2007 to validate acceptable indoor air quality at the quantity of outside air scheduled with the technology submitted. The manufacturer shall provide independent test data on a previous installation in a similar application that proves compliance to ASHRAE 62 and the accuracy of the calculations.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for ion generators including:

1. Schedule of plasma generators indicating unit designation, number of each type required for each unit/application.
2. Data sheet for each type of plasma generator, and accessory furnished; indicating construction, sizes, and mounting details.
3. Performance data for each type of plasma device furnished.
4. Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1-2007 to validate acceptable indoor air quality at the quantity of outside air scheduled (when projects are designed with outside air reduction).
5. Product drawings detailing all physical, electrical and control requirements.

B. Operating & Maintenance Data: Submit O&M data and recommended spare parts lists.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver in factory fabricated shipping containers. Identify on outside of container type of product and location to be installed. Avoid crushing or bending.

B. Store in original cartons and protect from weather and construction work traffic.

C. Store indoors and in accordance with the manufacturers' recommendation for storage.

1.7 WARRANTY

A. Equipment shall be warranted by the manufacturer against defects in material and workmanship for a period of twelve months after shipment or eighteen months from owner acceptance, whichever occurs first. Labor to replace equipment under warranty shall be provided by the owner or installing contractor.

PART 2 - PRODUCTS

2.1 GENERAL

A. The air purification system(s) shall be of the size, type, arrangement and capacity indicated and required by the unit furnished and shall be of the manufacturers specified.

B. Acceptable Manufacturers: Air+, Global Plasma Solutions and Plasma Air. No other manufacturers will be accepted.

1. In addition, manufacturers submitting for prior approval for Bi-Polar Ionization must as part of the prior approval request provide their ASHRAE 62.1-2010 calculations that prove

conformance to the ASHRAE Standard with the reduction of outside air to the scheduled values. A letter on the manufacturer's letterhead requesting prior approval must accompany the request for prior approval stating their calculations are ASHRAE compliant. A third party validation study performed on a previous installation of the same application shall also be included.

2.2 BI-POLAR IONIZATION DESIGN AND PERFORMANCE CRITERIA

A. Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a Plasma Generator with Bi-polar Ionization output as described here within. In-Duct unit(s) shall be provided for small to medium central HVAC systems with the number of units provided in accordance with the manufacturer's CFM capacity ratings.

B. The Bi-polar Ionization system shall be capable of:

1. Effectively killing microorganisms downstream of the bi-polar ionization equipment (mold, bacteria, virus, etc.).
2. Controlling gas phase contaminants generated from human occupants, building structure, furnishings and outside air contaminants.
3. Capable of reducing static space charges.
4. Effectively reducing space particle counts.

C. The bi-polar ionization system shall operate in a manner such that equal amounts of positive and negative ions are produced. Uni-polar ion devices shall not be acceptable.

1. Air exchange rates may vary through the full operating range of a constant volume or VAV system. The quantity of air exchange shall not be increased due to requirements of the air purification system.
2. Velocity Profile: The air purification device shall not have maximum velocity profile.

D. Humidity: Plasma Generators shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 100%, condensing, shall not cause damage, deterioration or dangerous conditions within the air purification system.

E. Equipment Requirements:

1. Electrode Specifications (Bi-polar Ionization):

a. Each Plasma Generator with Bi-polar Ionization output shall include the required number of electrodes and power generators sized to the air handling equipment capacity. Bi-polar ionization tubes manufactured of glass and steel mesh shall not be acceptable due to replacement requirements, maintenance, performance output reduction over time, ozone production and corrosion.
b. Electrodes shall be energized when the main unit disconnect is turned on and the fan is operating.
c. Manufacture shall demonstrate that no voltage potential exists due to exposed electrical components.

F. Air Handler Mounted Units:

1. Where so indicated on the plans and/or schedules Plasma Generator(s) shall be supplied and installed. The mechanical contractor shall mount the Plasma Generator and associated power supplies. All interconnecting wiring shall be UL and NEC NFPA 70 approved. Electrical contractor shall provide a circuit to the ion generators. Bar-type generators shall be

installed as scheduled. For installations that have a cooling coil height greater than 60 inches or where one bar is insufficient, multiple bars shall be installed on the entering face of the cooling coil.

G. Duct Mounted Units:

1. Where so indicated on the plans and/or schedules duct-mounted Plasma Generator(s) shall be furnished and installed. The mechanical contractor shall mount the Plasma Generator and associated power supplies. All interconnecting wiring shall be UL and NEC NFPA 70 approved. Electrical contractor shall provide a circuit to the ion generators.

H. Ionization Requirements:

1. Plasma Generators with Bi-polar ionization output shall be capable of controlling gas phase contaminants and shall be provided for all equipment listed above.

    a. The Bi-polar ionization system shall consist of Bi-Polar Plasma Generator and power supply. The Bi-polar system shall be installed where indicated on the plans or specified to be installed. The device shall be powered via the DDC with 24VAC. Ionization systems requiring isolation transformers shall not be acceptable. The units shall interface and energize with the AHU ON/OFF fan operation
    b. Ionization Output: The ionization output shall be controlled such that an equal number of positive and negative ions are produced. Imbalanced levels shall not be acceptable.
    c. Ionization output from each electrode shall be a minimum of 15 million ions/cc when tested at 2” from the ionization generator.

2. Ozone Generation:

    a. The operation of the electrodes or Bi-polar ionization units shall conform to UL 867-2007 with respect to ozone generation.

I. Power Requirements:

1. For the bar-type units in the AHU’s, the power supply shall be 120 volt, 12V DC or 24V AC as scheduled on the drawings.
2. For duct-mounted units the power supply shall be 24V AC from the supply fan terminals (standard), 120V AC to 12V DC wall-pack or 230V AC to 12V DC wall-pack as scheduled on the drawings.
3. Wiring, conduit and junction boxes shall be installed within housing plenums in accordance with NEC NFPA 70.

J. Control Requirements:

1. All Plasma Generators shall have internal short circuit protection, overload protection, and automatic fault reset.
2. The installing contractor shall mount and wire the Plasma device within the air handling unit or duct-mounted as specified or as shown or the drawings. The contractor shall follow all manufacturer IOM instructions during installation.
3. BAS Monitoring shall be provided via dry contact terminals.
4. Ionization systems by Global Plasma Solutions shall also include the ION Detect option for DDC interfacing and proof of ion generation.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall be responsible for maintaining all air systems until the owner accepts the building (Owner Acceptance).

3.2 ASSEMBLY AND ERECTION: PLASMA GENERATOR WITH BI-POLAR IONIZATION

A. All equipment shall be assembled and installed in a workman like manner to the satisfaction of the owner, architect, and engineer.

B. Any material damaged by handling, water or moisture shall be replaced, by the mechanical contractor, at no cost to the owner.

C. All equipment shall be protected from dust and damage on a daily basis throughout construction.

3.3 TESTING

A. Provide the manufacturers recommended electrical tests.

3.4 COMMISSIONING AND TRAINING

A. A manufacturer's authorized representative shall provide start-up supervision and training of owner's personnel in the proper operation and maintenance of all equipment.

END OF SECTION 23 43 24

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 73 13
AIR HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Basic Requirements: Provisions of Section 23 01 00, BASIC MECHANICAL REQUIREMENTS are a part of this Section.

1.2 SUMMARY

A. General: Provide air handling units as indicated, including appurtenances, accessories and service connections. Air handling unit shall be selected for custom dimensioning to meet the clearances in each mechanical room.

1.3 SUBMITTAL

A. General: Refer to paragraph entitled "SUBMITTAL" in Section 23 01 00. Include the following data:

1. Manufacturers Literature.
2. Performance Data:

    a. Provide the following information for each air handling unit:

        (1) Coil capacity at design conditions including air entering and leaving temperatures.
        (2) Coil descriptions, rows and fins per inch, and face velocity.
        (3) Air flow and airside pressure loss at design conditions.
        (4) Water flow and waterside pressure drop at design conditions.
        (5) Fan curve indicating design flow and brake-horsepower at scheduled static pressure, including drive losses.
        (6) Sound Data shall be provided for all AHU selections. Scheduled sound data shall not be exceeded for any AHU.

3. Maintenance Instructions:

    a. Manufacturer's printed instructions for the maintenance of each air handling unit.

1.4 APPLICABLE STANDARDS

A. General: All equipment, material, accessories, methods of construction and reinforcement, finish quality, workmanship and installation shall be in compliance with the paragraph entitled "Code Compliance" in Section 23 01 00.

B. Comply: With the National Fire Protection Association (NFPA) Standards and other Codes and Standards as adopted by the Local Authority having Jurisdiction.

C. NFPA: All materials and adhesives used shall conform to the requirements of NFPA 90A, 1999 Revision, and NFPA 255, 2000 Revision, with flame spread not exceeding 25 and smoke developed ratings not exceeding 50.

D. Performance: Supply fan performance shall be certified as complying with ARI Standard 430-89. Coil capacities, pressure drops and selection procedure shall be certified in accordance with ARI Standard 410-91.

1.5 MANUFACTURERS

A. Equipment items listed in the schedule on the drawings are based on a specific manufacturer to establish the desired style, quality, performance, and type of equipment. Equal products, complying with the required installation shown on the plans and with these specifications, by the following manufacturers are acceptable:

1. Trane.
2. Daikin. (Basis of Design).
3. York/JCI.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Single Source: All air handling units shall be of the same manufacturer. All components in factory-furnished air handling units shall be factory-assembled and factory-tested prior to shipping.

B. Condensate Drain Pan: Each unit shall have an insulated, 20-gauge stainless steel double wall drain pan for condensate drainage. Drain pan shall extend a minimum of six inches downstream of the coil face for inspection and access. The insulation shall be a minimum of 1 inch thick.

C. Sound Power Levels: Sound power levels in each band shall not exceed those indicated.

D. Fan Motor: Fan motors shall be electronically communicated type specifically designed for fan applications, unless otherwise indicated.

2.2 CENTRAL STATION AIR HANDLING UNIT

A. Manufacturer: Refer to paragraph entitled "MANUFACTURERS" in Section 23 01 00.

B. General:

1. Air handling unit shall be VAV with single path coils, as specified on the drawings.
2. Unit Casing: Units shall be of the sectional, unitized, bolt-together construction with gasketing where modules are joined. Units shall have a separate fan section and coil section. All enclosure panels on the units shall be fabricated from minimum 18-gauge galvanized steel (G-90) which has been chemically cleaned, phosphatized and ***factory-painted*** with an enamel finish. Unit shall be supported on a continuous six-inch base rail assembly. *Unit flooring shall be capable of supporting a 300 lb load.* All air handling units shall be shipped, designed, manufactured, compartmentalized, shipped and installed in order to physically fit into the building, through doors and set in place without the need to

remove doors, frames or walls, either during construction. The double-wall units shall also be capable of being dis-assembled/re-assembled for future break-down should any component require replacement in the future. The manufacturer and contractor shall carefully coordinate the actual shop drawing process/selections, shipping splits, specifically indicating the physical size of each section of the air handling unit. The fan section discharge opening shall be factory fabricated and sized for a maximum discharge velocity of 1,500 FPM.

3. Access Doors: Hinged insulated access doors shall provide access to the mixing air section, the inlet and outlet of each coil, the drain pan, and both sides of the internal fan drive and filter section. Latches for doors shall be industrial cam-lock type. Removing bolted sections of the air handling unit casing is not acceptable.
4. Fan Assemblies: Provide ECM, motorized impeller fan(s). Fan Assembly shall include fan, fan base and a motor and shall be dynamically balanced by the manufacturer.

    a. Motor control panel shall come with a low voltage terminal strip and shall include terminals for Fan ON/OFF, 0-10V signal, and fan fault.
    b. Motor control panel shall come equipped with a fused disconnect.
    c. Unit shall be provided with a ship loose motor control panel for the fan section. All motor wiring shall be field supplied and installed.
    d. Motor shall be brushless DC type with a permanent magnet rotor.
    e. Inverter shall be integral to the motor and come as an assembly from the fan manufacturer.

5. Sound Power Levels: Sound power levels in each band shall not exceed those indicated.
6. Bearings: Fans shall be equipped with self-aligning, anti-friction pillow block ball type bearings with a minimum life of 100,000 hours.
7. Provide positive pressure relief door handles or safety screen for fan access door.
8. Condensate Overflow Switch: Factory-installed to shut-off the unit in the event the drain pan is blocked.
9. Door Guard: Provide fan section with an expanded metal screen for the access door, mounted on the door opening to prevent accidental contact with rotating components.

C. Single Path Draw-Through:

1. General: Air handling units shall be single-path type as scheduled on the drawings.
2. Solid, Double-Wall Construction: ***ALL*** sections of the modular units shall be double-wall construction with minimum of 2-inch thickness, foam-injected (R-13) insulation. Insulation shall be continuous throughout the entire unit, including all panels, sections, spacers, seams and connections. The insulation shall be sandwiched between a minimum 20 gauge galvanized solid interior wall and the 18-gauge exterior wall.

D. Fan Capacity Control:

1. ECM Motors: Air handling unit electronically communicated fan motors shall be controlled through a factory-installed motor controller provided with the AHU.

2.3 COILS

A. Refrigerant Coils: Coils shall be leak tested to 200-psig air pressure underwater and designed for 300 psig working pressure. The coils shall be continuous seamless copper tube with aluminum plate fins bonded by mechanical expansion of the tubes, unless otherwise indicated. Fin spacing shall not exceed 12 per inch. Frames shall be constructed of minimum 16 -auge Type 304 stainless steel casing with copper headers brazed to tubes and threaded connections. Provide all coils with a factory applied electro-fin coil corrosion protection coating. Field applied coatings are not acceptable.

2.4 FILTERS

A. General: Filters section shall be flat type arrangement with individual gasketed rails to accept 2" thick pleated media pre-filter (30% efficiency/MERV-8) and a 4" thick pleated media (MERV-13) final filter section. Ship AHU's with the initial start-up set of filters until the units are ready for actual test and balancing. At project close-out, provide maintenance personnel with a complete set of pre-filters (MERV-8) for all AHU's with quantities necessary to provide one complete pre-filter change-out.

2.5 ACCESS SECTIONS

A. General: Double-wall, blank access sections with hinged, locking doors placed in the AHU modular components to allow inspection, coil cleaning/access and general maintenance access.

2.6 LIGHTING

A. Provide LED service lighting in the fan section and coil/access sections of each air handling unit. Lighting shall be factory pre-wired with a single point field connection for 120-volt power supply.

PART 3 - EXECUTION

3.1 GENERAL

A. Clearance: Layout and carefully install units with sufficient clearances to permit proper maintenance. The space required shall be as recommended by the manufacturer including the space required for removal of the coil and for filter maintenance.

B. Piping: valves, accessories and flanges or unions shall be so arranged that the removal of the coil piping shall provide unobstructed access for the removal of the coil.

C. Fins: Straighten fins for each coil, using a fin comb, prior to final acceptance. Coils having tubes with excessive broken fins shall be replaced at no additional cost to the Owner.

D. Dampers: All air handling units with a direct unconditioned outside air connection shall be provided with an opposed blade motorized damper in the outside air duct that closes whenever the unit fan is not energized.

3.2 VIBRATION ISOLATION

A. Equipment Mounting:

1. All fans shall be internally isolated and shall be free of vibration and shall not produce excessive noise. Refer to Section 23 05 48, VIBRATION ISOLATION EQUIPMENT. Isolators shall be sized for a minimum static deflection of 2 inches.

B. Duct Connections:

1. Internal fan drive units shall be provided with flexible duct connection inside the unit and in the supply and return duct connections as required to prevent transmission of vibration into the duct system. Refer to paragraph entitled "DUCT SYSTEM ACCESSORIES" in Section 23 33 00.

C. Piping Connections/Sizing:

1. Provide P-trap(s) in the condensate pan(s) drain connection. Each coil shall be independently piped to the nearest condensate/floor drain terminating with an air gap.
2. Refrigerant coil connections shall be selected for right/left hand as required. All piping and associated valves, etc. shall be installed with fittings to permit ease of maintenance and future coil removal. All piping to the coils shall be installed per the details on the drawings and to permit coil removal in the future.
3. Follow the manufacturer’s requirements for all refrigerant piping sizing, accessories, traps, etc.

3.3 EQUIPMENT SUPPORT

A. Installation: Install each unit on a housekeeping pad. Refer to paragraph entitled "HOUSEKEEPING PADS, CONCRETE" in Section 23 05 16.

END OF SECTION 23 73 13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 81 26
CONDENSING UNITS: AIR COOLED

PART 1 - GENERAL

1.1 SCOPE

A. Provide packaged air-cooled condensing units of the capacity, operating characteristics, and electrical characteristics indicated on drawings and specified herein.

1.2 SHOP DRAWINGS

A. Refer to Section entitled "General Mechanical Provisions". Include complete data on: unit dimensions; minimum operating and service clearances; capacities and rating conditions; maximum operating weights; power consumption; power and control wiring (both factory and field); and operating and safety controls.

1.3 MANUFACTURER

A. *Design Basis*: Daikin DX14A120.

1.4 COMPATIBILITY

A. Each unit must be compatible with evaporator coil arrangements and associated controls to which connected equipment is interfaced.

1.5 WARRANTY

A. Each condensing unit shall carry the standard full one-year warranty (parts & labor) and shall also include an additional full 4-year parts, labor and refrigerant warranty.

PART 2 - PRODUCTS

2.1 FRAME

A. Unit shall be completely factory assembled with all components mounted on a steel frame.

2.2 FINISH

A. The frame, all structural members, and sheet metal panels shall be properly cleaned, painted with a zinc rich primer, and finished with alkyd enamel.

2.3 COMPRESSOR AND MOTOR

A. The unit shall be provided with two-stage energy efficient compressors,

B. Compressors shall be isolated with resilient rubber isolators to decrease noise transmission.

C. Refrigeration capacity control shall be accomplished via staging of the compressors. Liquid tight conduit shall be provided on exposed conduit wire.

D. Each compressor shall have motor temperature sensing and current sensing overload protection.

E. Unit shall have single refrigerant circuit. Refrigerant shall be R-410A.

2.4 CONDENSER

A. Condenser coils shall be fabricated from cast aluminum micro-channel coils. Each condenser coil shall be factory leak-tested with high pressure under water. Each refrigerant circuit shall provide 15 degrees sub-cooling.

2.5 CONDENSER FANS

A. Direct drive, propeller type with fan guards.

B. Unit shall have at least one condenser fan controlled to maintain positive head pressure.

C. Fan motors shall have thermal overload relays for running protection.

2.6 CONTROLS

A. Unit shall be provided with a low pressure and high-pressure safety for each circuit.

B. Unit shall be provided with a 24-volt terminal strip for field installed controls.

C. Unit manufacturer shall provide necessary relays for cooling stages as stated on the equipment schedule.

2.7 OPTIONS AND ACCESSORIES

A. Unit shall be provided with a factory-applied, electro-fin baked epoxy coating with a 5000-hour salt-spray test per ASTM B117.

B. Liquid line kit for each circuit with sight glass, solenoid valve and replaceable core filter-drier.

C. Vandal-Guards.

2.8 FACTORY PREWIRING

A. Unit shall be factory wired with power connections brought out to a single set of terminal lugs for field connection.

PART 3 - EXECUTION

3.1 UNIT PLACEMENT

A. The unit location shall be essentially as shown on drawings; however, actual placement shall be verified using field measurements and data relating to the equipment approved for actual installation on this project.

B. Concrete Equipment Pad: Provide a concrete equipment pad, six inches larger than the footprint of the unit in all directions. The Pad shall be at a depth with the top of pad at 6 inches above finished grade. Provide a NOA rated condenser stand, minimum 24 inches in height, anchored to the concrete pad as manufactured by Miami-Tech or approved equal. Place unit on neoprene isolators prior to anchoring to the stand. Secure the unit with minimum of two ¼" stainless steel, vinyl coated aircraft cables with stainless steel turnbuckles.

3.2 COORDINATION

A. Refer to Sections describing refrigerant piping systems and air handling units with DX refrigerant coils. Provide all piping, hangers, supports, valves, and specialty items as required for a complete and operable system.

3.3 TEST AND BALANCE

A. Refer to Sections describing tests and balancing.

END OF SECTION 23 81 26

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 81 31
AIR CONDITIONING UNITS: SPLIT SYSTEM DUCTLESS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes ductless split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for fully exposed or partially concealed mounting and may be connected to small branch and outside air ducts.

1.2 SUBMITTALS

A. Product Data: For each unit indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

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

1.4 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace split-system air-conditioning units that fail in materials and workmanship within the following specified number of years from date of Substantial Completion:

1. Entire unit: 1-year parts and labor.
2. Compressor: 6 years parts and labor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Mitsubishi.
2. Daikin. (Basis of Design).

2.2 EVAPORATOR-FAN UNIT

A. Exposed, Wall Mounted Unit Cabinet: Fabricated of cold roll steel with structural stiffness.

1. Insulation: Faced, glass-fiber duct liner.
2. Drain Pans: Galvanized steel, with connection for drain; insulated.
3. Intake Grille: High impact polystyrene air inlet panel.
4. Discharge Grille: High temp noryl.
5. Evaporator Fan: Tangential type.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Fan Motor: Multispeed.

D. Filters: Permanent, electrostatic, cleanable.

E. Condensate Pump: Where scheduled.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER UNIT

A. Casing steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed reciprocating or scroll type with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid sub-cooler.

D. Fan: Aluminum-propeller type, directly connected to motor.

E. Motor: Permanently lubricated, with integral thermal-overload protection.

F. Low Ambient Kit: Permits operation down to 20 deg F.

G. Mounting: Mount the unit on an aluminum condenser stand. Miami-tech or equal. Provide 2 PVC coated S.S. aircraft tie-down cables with turnbuckles and stainless steel hardware.

H. Provide seacoast coating on all of the components of the condensing unit.

2.4 ACCESSORIES

A. Thermostat: Provide with optional remote. Low voltage with sub-base to control compressor and evaporator fan.

B. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

C. Infrared Control: Provide with factory infrared controls and remote operator.

D. Time Delay: Provide with short cycle time delay.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

B. Install compressor-condenser components on NOA rated aluminum condenser stand with two ¼” vinyl coated stainless steel aircraft cable tie-downs.

3.2 CONNECTIONS

A. Connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

B. Connect supply and return water coil with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

C. Connect supply and return condenser connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

D. Install piping adjacent to the unit to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.

B. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new components, and retest.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 23 81 31

THIS PAGE INTENTIONALLY LEFT BLANK

Division 26

Electrical

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 01 00
BASIC ELECTRICAL REQUIREMENTS

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 work of this Section.

B. Coordination of work between mechanical and electrical trades is covered in Division-23 Section “GENERAL MECHANICAL PROVISIONS”.

1.2 SUMMARY

A. This Section specifies the basic requirements for electrical installations and includes requirements common to all sections of Division-26. It expands and supplements the requirements specified in sections of Division-01.

1.3 CODES AND STANDARDS

A. Install all work in accordance with the applicable requirements of the latest edition of the following:

1. National Electric Code (NEC)
2. Local, State, County and City Codes
3. National Fire Protection Association (NFPA)
4. American National Standards Institute (ANSI)
5. NEMA Standards

B. It is the intent of the Contract Documents to comply with the applicable codes, ordinances, regulations, and standards. Where discrepancies occur, notify the Architect in writing, and ask for interpretation. Correct any installation that fails to comply with the applicable codes and standards at no additional cost to the Owner.

C. All materials shall be new and free of defects, and shall be U.L. listed, bear the U.L. label or be labeled or 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.

1.4 PERMITS AND INSPECTIONS

A. Obtain and make all payments for permits and inspections required. At the completion of the project and before final acceptance of the electrical work, provide evidence of final inspection and approval by the authorities having jurisdiction.

1.5 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of electrical products specified, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with electrical work similar to that required for this project.

1.6 IDENTIFICATION

A. The following items shall be equipped with nameplates: All motors, motor starters, motor-control centers, pushbutton stations, control panels, time switches, disconnect switches, panelboards, circuit breakers, contactors.

B. Nameplates shall adequately describe the function of the particular equipment involved. Nameplates for panelboards and switchboards shall include the panel designation, branch (normal or emergency), voltage and phase of the supply. For example, "Panel A, Emergency Branch, 480Y/277V, 3-phase, 4-wire."

C. Nameplates shall be laminated phenolic plastic, black front and back with white core, with 3/8" high lettering etched through the outer covering. White engraved letters on black background. Attach with plated self-tapping screws or brass bolts.

D. Provide nameplates on all existing equipment that a circuit under this contract is fed from.

E. All junction box covers shall be hand marked with a 1/8" wide permanent black marking pen, indicating panel and circuit numbers contained, or system contained, i.e., fire alarm, telephone, etc.

1.7 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected, and architectural room elevations.

1.8 ELECTRICAL INSTALLATIONS

A. Coordinate electrical equipment and materials installation with other building components.

B. Verify all dimensions by field measurements.

C. Arrange for chases, slots, and openings in other building components to allow for electrical installations.

D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

E. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

F. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.

G. Coordinate connection of electrical systems with local utility services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connections for each service.

1.9 CUTTING AND PATCHING

A. This Article specifies the cutting and patching of electrical equipment, components, and materials to include removal and legal disposal of selected materials, components, and equipment.

B. Do not endanger or damage installed Work through procedures and processes of cutting and patching.

C. Arrange for repairs required to restore other work, because of damage caused as a result of electrical installations.

D. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.

E. Perform cutting, fitting, and patching of electrical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed work.
2. Remove and replace defective work.
3. Remove and replace Work not conforming to requirements of the Contract Documents.
4. Remove samples of installed Work as specified for testing.
5. Upon written instructions from the Architect/Engineer, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.
6. Install electrical work in existing facilities.

1.10 ELECTRICAL SUBMITTALS

A. Refer to the Conditions of the Contract (General and Supplementary) and Division-01 Section: SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES for submittal definitions, requirements, and procedures.

B. Submittal of shop drawings, product data, and samples will be accepted only when submitted by the Contractor. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed.

1.11 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Refer to the Instructions to Bidders and the Division-01 for requirements in selecting products and requesting substitutions. Where a listing of acceptable manufacturers has been given, use one of those manufacturers given only.

1.12 PRODUCT LISTING

A. Prepare listing of major electrical equipment and materials for the project.

B. Provide all information requested.

C. When two or more items of the same material or equipment are required they shall be of the same manufacturer, i.e., panelboards, motor starters, transformers, etc. Product manufacturer uniformity does not apply to raw materials, bulk materials, wire, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in Work, except as otherwise indicated.

D. Provide products which are compatible within systems and other connected items.

1.13 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

C. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.14 RECORD DOCUMENTS

A. Refer to the Division-01 Section: PROJECT CLOSEOUT or PROJECT RECORD DOCUMENTS for requirements. The following paragraphs supplement the requirements of Division-01.

B. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details.

C. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

1.15 OPERATION AND MAINTENANCE DATA

A. Refer to the Division-01 Section; PROJECT CLOSEOUT or OPERATION AND MAINTENANCE DATA for procedures and requirements for preparation and submittal of maintenance manuals.

1.16 WARRANTIES

A. Refer to individual equipment specifications for warranty requirements.

B. Compile and assemble the warranties specified in Divisions-26, 27 & 28, into a separate set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.17 CLEANING

A. Refer to the Division-01 Section; PROJECT CLOSEOUT or FINAL CLEANING for general requirements for final cleaning.

B. Clean all light fixtures, lamps and lenses prior to final acceptance. Replace all inoperative lamps.

1.18 TEMPORARY POWER

A. Provide and pay for all temporary electrical service as required for construction.

B. Provide all temporary lighting and power distribution as required for construction. All temporary electrical work shall be in accordance with the N.E.C.

1.19 ELECTRONIC FILES

A. CADD files and REVIT files will be available on a limited basis to the contractors. Recipients are cautioned that these files may not accurately show actual conditions as constructed. Users are responsible to verify actual field conditions. These files are not intended to be used as shop drawings.

B. A request for electronic drawing files should be delivered in writing along with the Engineer of Record drawing release form by the for such files. Files will not be processed until a signed release form is received.

1.20 EXISTING CONDITIONS

A. Prior to bid, the Contractor shall visit the existing facility and become familiar with existing conditions. Contractor shall include in his bid price, allowances for work to be performed in the existing operational areas of the facility. All work in existing operational areas shall be coordinated and scheduled with the facility and may have to be performed during non-normal working hours.

B. All existing ceilings and finishes removed for installation of work under this Contract shall be replaced or returned to "like new" condition.

C. Existing piping, conduit and ductwork are located in areas of construction under this Contract. Contractor shall relocate or modify any existing piping, conduit or ductwork. Shutdown of existing systems for relocation shall be coordinated with the facility.

D. Before any construction begins, it shall be the responsibility of the Contractor to investigate and coordinate proposed new ceiling heights with existing conditions and ceiling space requirements for new lighting fixtures, ductwork, sprinkler, plumbing, piping and conduit systems.

E. It shall be the Contractor's responsibility to adjust existing and new ductwork, sprinkler, plumbing, piping and conduit systems to accommodate the work in the ceiling height provided. Architect shall be notified before construction begins if any ceiling space is not adequate for the work shown.

END OF SECTION 26 01 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

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

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

2.2 CONNECTORS AND SPLICES

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

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Feeders: Type THHN-THWN, single conductors in raceway

C. Branch Circuits: Type THHN-THWN, single conductors in raceway

D. Class 1 Control Circuits: Type THHN-THWN, in raceway.

E. Class 2 Control Circuits: Type THHN-THWN, in raceway, unless specified otherwise.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

    a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

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

END OF SECTION 26 05 19

SECTION 26 05 26
GROUNDING AND BONDING 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. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Common ground bonding with lightning protection system.

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. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Stranded Conductors: ASTM B 8.
2. Tinned Conductors: ASTM B 33.
3. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
4. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet in length minimum, 20 feet in length where indicated.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade.

C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Armored and metal-clad cable runs.
7. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
8. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater: Install a separate insulated equipment grounding conductor to each electric water heater. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from

panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. For telephone, alarm, voice and data, and other communication equipment, provide No. 6 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

G. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

G. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.

1. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches from building's foundation.

H. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
b. Perform tests by fall-of-potential method according to IEEE 81.

B. Grounding system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. Report measured ground resistances that exceeds 5 ohms.

END OF SECTION 26 05 26

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

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

1) Cooper B-Line, Inc.; a division of Cooper Industries.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or spring-tension clamps.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete (Limited Applications)."

C. Anchor equipment to concrete base.

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

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Surface raceways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. FMC: Flexible metal conduit.

D. GRC: Galvanized Rigid (steel) Conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. RNC: Rigid nonmetallic conduit.

1.3 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.
2. For handholes and boxes for underground wiring, including the following:

a. Duct entry provisions, including locations and duct sizes.
b. Frame and cover design.
c. Grounding details.
d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
e. Joint details.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

1.4 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.
4. Electri-Flex Company.
5. O-Z/Gedney; a brand of EGS Electrical Group.
6. Southwire Company.
7. Thomas & Betts Corporation.
8. Wheatland Tube Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

F. EMT: Comply with ANSI C80.3 and UL 797.

G. FMC: Comply with UL 1; zinc-coated steel.

H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Fittings for EMT:

a. Material: Steel.
b. Type: Set-screw or compression.

2. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
4. All metallic fittings shall be furnished with zinc-coating, or other approved application.

J. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.
3. Arnco Corporation.
4. CANTEX Inc.
5. Carlon Corp.
6. Condux International, Inc.
7. Electri-Flex Company.
8. Lamson & Sessions; Carlon Electrical Products.
9. RACO; a Hubbell company.
10. Thomas & Betts Corporation.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ENT: Comply with NEMA TC 13 and UL 1653.

D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. LFNC: Comply with UL 1660.

F. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

G. Fittings for LFNC: Comply with UL 514B.

2.3 METAL WIREWAYS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

1. Cooper B-Line, Inc.

2. Hoffman.
3. Square D; Schneider Electric.

C. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 or 3R, unless otherwise indicated.

D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

E. Wireway Covers: Hinged type, Flanged-and-gasketed type.

F. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

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

a. Hubbell Incorporated; Wiring Device-Kellems.
b. MonoSystems, Inc.
c. Panduit Corp.
d. Wiremold / Legrand.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Technologies Company; Cooper Crouse-Hinds.
2. Hoffman; a Pentair company.
3. Hubbell Incorporated; Killark Division.
4. O-Z/Gedney; a brand of EGS Electrical Group.
5. RACO; a Hubbell Company.
6. Robroy Industries.
7. Thomas & Betts Corporation.
8. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations. Stamped steel boxes shall not be used in exposed areas.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Metal Floor Boxes:

1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

J. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.

1. Color of Frame and Cover: Gray.
2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "COMMUNICATIONS" or “ELECTRICAL”.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

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

3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit.
2. Concealed Conduit, Aboveground: EMT
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
6. Application of Handholes and Boxes for Underground Wiring:

    a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete SCTE 77, Tier 15 structural load rating.
    b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.
    c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.

B. Indoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT
3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Raceway locations include the following, at a minimum:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: Rigid steel conduit.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
8. Raceways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
9. Raceways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT.
10. Raceways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber/communications-cable raceway or EMT.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
3. EMT: Use setscrew (indoor) or compression (outdoors), steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits in contact with concrete.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter.

B. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

C. Do not fasten conduits onto the bottom side of a metal deck roof.

D. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

E. Complete raceway installation before starting conductor installation.

F. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

G. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

H. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

I. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

J. Support conduit within 12 inches of enclosures to which attached.

K. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

3. Change to GRC before rising above floor. Conduit shall be GRC for a minimum of 6 inches above penetration.
4. Protect conduit from corrosion at penetration through slab with bituminous mastic.

L. Stub-Ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

N. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly

O. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

Q. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

S. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

U. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size: Install raceways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

V. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

W. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

X. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Conduit extending from interior to exterior of building.
4. Conduit extending into pressurized duct and equipment.
5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6. Where otherwise required by NFPA 70.

Y. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

Z. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

AA. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires**,** equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations.

BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

CC. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

DD. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

EE. Locate boxes so that cover or plate will not span different building finishes.

FF. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

GG. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

HH. Set metal floor boxes level and flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom.
2. Install backfill.
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

6. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 05 43
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
2. Rigid nonmetallic duct.
3. Duct accessories.
4. Precast concrete handholes.
5. Polymer concrete handholes and boxes with polymer concrete cover.

1.2 DEFINITION

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:

1. Two or more ducts installed in parallel, with or without additional casing materials.
2. Multiple duct banks.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for manholes, handholes, boxes, and other utility structures.
4. Warning tape.

B. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

C. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Reinforcement details.
3. Frame and cover design and manhole frame support rings.
4. Ladder details.
5. Grounding details.

6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
7. Joint details.

D. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
3. Grounding details.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

E. Source quality-control test reports.

F. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.6 COORDINATION

A. Coordinate layout and installation of ducts, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

A. GRC: Comply with ANSI C80.1 and UL 6.

B. Coated Steel Conduit: PVC-coated GRC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

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

1. AFC Cable Systems; a part of Atkore International.
2. Allied Tube & Conduit; a part of Atkore International.
3. Anamet Electrical, Inc.
4. Calconduit.
5. Electri-Flex Company.
6. FSR Inc.
7. Korkap.
8. NEC, Inc.
9. Opti-Com Manufacturing Network, Inc (OMNI).
10. O-Z/Gedney; a brand of Emerson Industrial Automation.
11. Perma-Cote.
12. Picoma Industries, Inc.
13. Plasti-Bond.
14. Republic Conduit.
15. Southwire Company.
16. Thomas & Betts Corporation; A Member of the ABB Group.
17. Topaz Electric; a division of Topaz Lighting Corp.
18. Western Tube and Conduit Corporation.
19. Wheatland Tube Company.

D. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

A. Underground Plastic Utilities Duct: Type EPC-80-PVC RNC and Type EPC-40-PVC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

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

1. ARNCO Corp.
2. Beck Manufacturing.
3. CANTEX INC.
4. CertainTeed Corporation.
5. Condux International, Inc.
6. Crown Line Plastics.
7. ElecSys, Inc.

8. Electri-Flex Company.
9. Endot Industries Inc.
10. IPEX USA LLC.
11. Lamson & Sessions.
12. Manhattan/CDT.
13. National Pipe & Plastics.
14. Opti-Com Manufacturing Network, Inc (OMNI).
15. Spiraduct/AFC Cable Systems, Inc.

C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

D. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

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

a. Allied Tube & Conduit; a part of Atkore International.
b. CANTEX INC.
c. Carlon; a brand of Thomas & Betts Corporation.
d. IPEX USA LLC.
e. PenCell Plastics.
f. Underground Devices, Inc.

B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 26 05 53 "Identification for Electrical Systems."

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

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

1. Christy Concrete Products.
2. Elmhurst-Chicago Stone Co.
3. Oldcastle Precast, Inc.
4. Rinker Group, Ltd.
5. Riverton Concrete Products.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.

C. Comply with ASTM C 858 for design and manufacturing processes.

D. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

E. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

F. Cover Legend: Molded lettering, as indicated for each service.

G. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

H. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

1. Extension shall provide increased depth of 12 inches.
2. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

I. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

J. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

K. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

L. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.5 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

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

1. Armorcast Products Company.
2. NewBasis.
3. Oldcastle Enclosure Solutions.
4. Quazite: Hubbell Power Systems, Inc.

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: Gray.

E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, as indicated for each service.

I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.6 SOURCE QUALITY CONTROL

A. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

3.2 UNDERGROUND DUCT APPLICATION

A. Duct for Electrical Cables More Than 600 V: Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.

B. Duct for Electrical Feeders 600 V and Less: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.

C. Duct for Electrical Branch Circuits: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.

D. Bored Underground Duct: Type EPEC-40 HDPE unless otherwise indicated.

E. Underground Ducts Crossing Paved Paths, Walks, Driveways, Roadways, and Railroads: RNC Type EPC-40 PVC, encased in reinforced concrete.

F. Stub-ups: Concrete-encased GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
5. Cover design load shall not exceed the design load of the handhole or box.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Section 31 20 00 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Replace area immediately after backfilling is completed and after construction vehicle traffic in immediate area is complete.

C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 32 92 00 "Turf and Grasses" and Section 32 93 00 "Plants."

E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 01 73 00 "Execution."

3.5 DUCT AND DUCT-BANK INSTALLATION

A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.

B. Install duct according to NEMA TCB 2.

C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.

D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.

1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.

E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.

F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

G. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell, without reducing duct slope and without forming a trap in the line.
2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch.
3. Grout end bells into structure walls from both sides to provide watertight entrances.
4. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line duct with calculated expansion of more than 3/4 inch.

H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.

I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

J. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

K. Pulling Cord: Install 200-lbf-test nylon cord in empty ducts.

L. Concrete-Encased Ducts and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 31 20 00 "Earth Moving" for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.

4. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
5. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
6. Minimum Space between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.
7. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.

    a. Couple RNC duct to GRC with adapters designed for this purpose and encase coupling with 3 inches of concrete.
    b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.

    c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.

8. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
9. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
10. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.
11. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.

12. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 03 30 00 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

M. Direct-Buried Duct and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 31 20 00 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Width: Excavate trench 3 inches wider than duct on each side.
4. Depth: Install top of duct at least 36 inches below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct bank below frost line.
6. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
8. Install duct with a minimum of 3 inches between ducts for like services and 6 inches between power and communications duct.
9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.

    a. Couple RNC duct to GRC with adapters designed for this purpose and paint with black mastic to protect the entire elbow.
    b. Stub-ups to Outdoor Equipment: GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.

    c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.

11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 31 20 00 "Earth Moving" for installation of backfill materials.

    a. Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.
    b. Place minimum 6 inches of engineered fill above concrete encasement of duct.

N. Underground-Line Warning Tape: Bury underground line specified in Section 26 05 53 "Identification for Electrical Systems" no less than 12 inches above all concrete-encased duct

and duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
4. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

E. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 07 11 13 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, as required for installation and support of cables and conductors and as indicated.

G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, 28-day strength, complying with Section 03 30 00 "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep.

3.8 GROUNDING

A. Ground underground ducts and utility structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch-long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.10 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump.

1. Sweep floor, removing dirt and debris.
2. Remove foreign material.

END OF SECTION 26 05 43

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 05 44
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

2.5 FIRE RATED RACEWAY AND CABLE PENETRATION

A. System used for penetrations shall be NRTL listed as suitable for the purpose and shall maintain the original fire rating of the penetrated floor, wall, etc.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work. Roof penetrations shall be avoided if at all possible.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical

sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.2 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.3 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

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

C. Coordinate installation of identifying devices with location of access panels and doors.

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

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field
2. Legend: Indicate voltage.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Single Conductor Control Wires: Identify with pre-printed sleeve type heat-shrink marker, with wire number, at each termination.

2.5 FLOOR MARKING TAPE

A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.7 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following example legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.8 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.9 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled with self-tapping screws or brass bolts. White letters on a black background. Minimum letter height shall be 3/8 inch.

2.10 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, according to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, according to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, according to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.11 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Panelboard engraved labels shall be mechanically fastened using rivets or screws.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at 30-foot maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Power.
3. UPS.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
b. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

    a. Power transfer switches.
    b. Controls with external control power connections.

J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

    a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high. Follow the Gulfstream panelboard labeling scheme.
    b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
    c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

    a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
    b. Enclosures and electrical cabinets.
    c. Access doors and panels for concealed electrical items.
    d. Switchboards.
    e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
    f. Emergency system boxes and enclosures.
    g. Enclosed switches.
    h. Enclosed circuit breakers.
    i. Enclosed controllers.
    j. Variable-speed controllers.
    k. Power transfer equipment.

l. Power-generating units.
m. Monitoring and control equipment.

END OF SECTION 26 05 53

SECTION 26 05 73.16
COORDINATION STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1. Coordination of series-rated devices is not permitted.
2. Result shall be an electrical system with fully rated selectively coordinated overcurrent devices.
3. Scope of study shall include all new electrical equipment and installations and all existing installations that are affected by the new.

1.2 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study and fault-current study specialist.

D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed.

1. Coordination-study and fault-current study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study and Fault-Current Study Report.
4. Arc Flash Report.

1.3 QUALITY ASSURANCE

A. Studies shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

D. Power System Analysis Software Qualifications:

1. Computer program shall be designed to perform coordination studies or have a function, component, or add-on module designed to perform coordination studies.

E. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Basis-of-Design Product: Provide computer analysis with SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Additional Features:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

2.3 COORDINATION STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.
6. Any revisions to electrical equipment required by the study.
7. Study Input Data: As described in "Power System Data" Article.

a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 05 73.13 "Short-Circuit Studies."

D. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

a. Phase and Ground Relays:

1) Device tag.
2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
3) Recommendations on improved relaying systems, if applicable.

b. Circuit Breakers:

1) Adjustable pickups and time delays (long time, short time, and ground).
2) Adjustable time-current characteristic.
3) Adjustable instantaneous pickup.
4) Recommendations on improved trip systems, if applicable.

E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:

a. Power utility's overcurrent protective device.
b. Medium-voltage equipment overcurrent relays.
c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
f. Cables and conductors damage curves.
g. Ground-fault protective devices.
h. Motor-starting characteristics and motor damage points.
i. Generator short-circuit decrement curve and generator damage point.
j. The largest feeder circuit breaker in each motor-control center and panelboard.

5. Maintain selectivity for tripping currents caused by overloads.
6. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.

7. Provide adequate time margins between device characteristics such that selective operation is achieved.
8. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the overcurrent protective device study.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call any discrepancies to Architect's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.

B. Gather and tabulate all required input data to support the coordination study. List below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Electrical power utility impedance at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.

12. Maximum demands from service meters.
13. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
14. Motor horsepower and NEMA MG 1 code letter designation.
15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
16. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).
17. Data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices indicated to be coordinated.
    h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.
    k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.3 COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. Base study on device characteristics supplied by device manufacturer.

D. Begin analysis at the service, extending down to system overcurrent protective devices as follows:

    1. To normal system low-voltage load buses where fault current is 10 kA or less.

E. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

F. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

G. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

H. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

I. Generator Protection: Select protection according to manufacturer's written instructions and to IEEE 242.

J. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.

K. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

L. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Include in the report identification of any protective device applied outside its capacity.

3.4 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:

1. Determine load flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
2. Determine load flow and voltage drop based on 80 percent of the design capacity of load buses.

3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.5 FIELD ADJUSTING

A. Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of equipment manufacturer under the "Startup and Acceptance Testing" contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with[short-circuit and protective device coordination studies.

C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

3.6 DEMONSTRATION

A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in the following:

1. Acquaint personnel in fundamentals of operating the power system in normal and emergency modes.
2. Hand-out and explain the coordination study objectives, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting time-current coordination curves.

END OF SECTION 26 05 73.16

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following lighting control devices:

1. Photoelectric switches.
2. Indoor occupancy sensors.
3. Lighting contactors.
4. Time Switches.
5. Emergency shunt relays.

1.2 SUBMITTALS

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

B. Field quality-control test reports.

C. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

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.

1.4 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. NSi Industries LLC; TORK Products.
4. Tyco Electronics; ALR Brand.

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Fifteen second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor.
5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 INDOOR OCCUPANCY SENSORS

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

1. Hubbell Lighting.
2. Leviton Mfg. Company Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Sensor Switch, Inc.
5. TORK.
6. Watt Stopper (The).
7. N-Light

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
4. Mounting:
    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

B. Wall-Switch Sensor:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 2100 sq. ft.
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
4. Voltage: Dual voltage, 120 and 277 V; dual-technology type.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.4 LIGHTING CONTACTORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by the following:

1. Square D; Schneider Electric.

D. Description: Electrically operated and mechanically held, combination type with fusible switch, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).

2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings scheduled, matching the NEMA type specified for the enclosure.

2.5 TIME SWITCHES

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

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Invensys Controls.
4. Leviton Manufacturing Co., Inc.
5. NSi Industries LLC.
6. TE Connectivity Ltd.

B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
2. Contact Rating: 30-A inductive or resistive, 240-V ac.
3. Programs: Eight on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
4. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
5. Astronomic Time: All channels.
6. Automatic daylight savings time changeover.

2.6 EMERGENCY SHUNT RELAY

A. Description: NC, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 120 or 277 V.

2.7 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to four visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 26 09 23

SECTION 26 09 43
NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes manually operated lighting controls with relays control module.

1.2 DEFINITIONS

A. BACnet: A networking communication protocol that complies with ASHRAE 135.

B. BAS: Building automation system.

C. DALI: Digital addressable lighting interface.

D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.

E. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

F. RS-485: A serial network protocol, similar to RS-232, complying with TIA-485-A.

G. UTP: Unshielded twisted pair.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, manual switches and plates, and conductors and cables.

B. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

D. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of lighting control functions.
2. Coordinate lighting controls with BAS. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.

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

a. Failure of software input/output to execute switching or dimming commands.
b. Failure of modular relays to operate under manual or software commands.
c. Damage of electronic components due to transient voltage surges.

2. Warranty Period: Two years from date of Substantial Completion.

1.7 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. LC&D.
2. Lutron Electronics Co., Inc.
3. Crestron.
4. Watt Stopper/Legrand.
5. System Sensor N-Light.

2.2 SYSTEM REQUIREMENTS

A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

B. Performance Requirements: Manual switch operation sends a signal to network-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits to groups of lighting fixtures or other loads.

C. BAS Interface: Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports.

2.3 CONTROL MODULE

A. Control Module Description: Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Unit shall be networked for control of indicated number of output circuits. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices, all located in other enclosures. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral alphanumeric LCD shall display manual-control and programming steps.

2.4 POWER DISTRIBUTION COMPONENTS

A. Modular Relay Panel: Comply with UL 508 (CAN/CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.

1. Cabinet: Steel with hinged, locking door.

    a. Barriers separate low-voltage and line-voltage components.
    b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
    c. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.

2. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.

    a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
    b. Rated Capacity (Mounted in Relay Panel): 20 A, 125-V ac for tungsten filaments; 20 A, 277-V ac for ballasts.
    c. Endurance: 50,000 cycles at rated capacity.
    d. Mounting: Provision for easy removal and installation in relay cabinet.

B. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels.

2.5 MANUAL ANALOG SWITCHES AND PLATES

A. Push-Button Switches: Modular, momentary-contact, low-voltage type.

1. Match color specified in Division 26 Section "Wiring Devices."
2. Integral green LED pilot light to indicate when circuit is on.
3. Internal white LED locator light to illuminate when circuit is off.

B. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.6 FIELD-MOUNTED DIGITAL CONTROLS AND PLATES

A. Connection Type: RS-485 protocol, category 5e UTP cable, using RJ45 connectors. Power shall be from the control unit.

B. Pushbutton Switches: Modular, solid-state, programmable, digital, momentary contact, designed to connect to a microprocessor based control unit as a manual control source.

1. Mounting: Standard single-gang recessed switchbox, using device plates specified in Division 26 Section "Wiring Devices."
2. Multi-Gang Mounting: One to six pushbuttons per gang.

2.7 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

D. Structured Network Digital and Multiplexed Signal Cables: UTP cable with copper conductors, complying with TIA/EIA-568-B.2, Category 6 for horizontal copper cable and with Division 27 Section "Communications Horizontal Cabling."

E. RS-485 Cables:

1. Standard Cable: NFPA 70, Type CM or CMG.

a. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
b. PVC insulation.
c. Unshielded.
d. PVC jacket.
e. Flame Resistance: Comply with UL 1581.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install wiring in raceways except where installed in accessible ceilings. Minimum conduit size shall be 1/2 inch.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

D. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

E. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.

G. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Test for circuit continuity.
2. Verify that the control module features are operational.
3. Check operation of local override controls.
4. Test system diagnostics by simulating improper operation of several components.

C. Lighting controls will be considered defective if they do not pass tests and inspections.

3.3 SOFTWARE INSTALLATION

A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train owner's maintenance personnel to adjust, operate, and maintain lighting controls.

END OF SECTION 26 09 43

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals.

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

E. Enclosures: Flush and Surface mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

2. Height: 84 inches maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:

a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Same finish as panels and trim.

7. Directory Card: Inside panelboard door, mounted in transparent card holder.

F. Incoming Mains:

1. Location: Convertible between top and bottom.
2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

G. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

a. Plating shall run entire length of bus.
b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.

3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

H. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type.
6. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

I. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

J. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: 20 percent.

K. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

2.2 POWER PANELBOARDS

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

1. Square D; a brand of Schneider Electric.
2. Eaton Electrical Inc.; Cutler-Hammer.
3. General Electric Company
4. Siemens Energy & Automation, Inc.

B. Panelboards: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: As indicated on Drawings.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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

1. Square D; a brand of Schneider Electric.
2. Eaton Electrical Inc.; Cutler-Hammer.
3. General Electric Company
4. Siemens Energy & Automation, Inc.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: As indicated on Drawings.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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

1. Square D; a brand of Schneider Electric.
2. Eaton Electrical Inc.; Cutler-Hammer.
3. General Electric Company
4. Siemens Energy & Automation, Inc.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

   a. Inverse time-current element for low-level overloads.
   b. Instantaneous magnetic trip element for short circuits.
   c. Adjustable magnetic trip setting for circuit-breaker frame sizes 200 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip, 100 percent rated circuit breakers shall be provided for circuit breaker frame sizes 400A and larger. Provide with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

   1) Instantaneous trip.
   2) Long- and short-time pickup levels.
   3) Long and short time adjustments.
   4) Ground-fault pickup level, time delay, and I squared T response.

4. As required by panelboard schedules:

   a. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
   b. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
   c. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
   d. Subfeed Circuit Breakers: Vertically mounted.

5. Molded-Case Circuit-Breaker MCCB Features and Accessories:

   a. Standard frame sizes, trip ratings, and number of poles.
   b. Breaker handle indicates tripped status.
   c. UL listed for reverse connection without restrictive line or load ratings.
   d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
   f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   g. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.5 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

   1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NEMA PB 1.1.

D. Equipment Mounting:

1. Attach panelboard to the vertical finished or structural surface behind the panelboard.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Mount top of trim 90 inches above finished floor unless otherwise indicated.

G. Mount panelboard cabinet plumb and rigid without distortion of box.

H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

J. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

K. Install filler plates in unused spaces.

L. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

M. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

N. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate."

E. Install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:

        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73.16 "Coordination Studies."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

END OF SECTION 26 24 16

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Standard-grade receptacles, 125 V, 20 A.
2. USB receptacles.
3. GFCI receptacles, 125 V, 20 A.
4. Twist-locking receptacles.
5. Pendant cord-connector devices.
6. Cord and plug sets.
7. Toggle switches, 120/277 V, 20 A.
8. Wall-box dimmers.
9. Wall plates.
10. Floor service fittings.
11. Prefabricated multioutlet assemblies.
12. Service poles.

1.2 DEFINITIONS

A. AFCI: Arc-fault circuit interrupter.

B. BAS: Building automation system.

C. GFCI: Ground-fault circuit interrupter.

D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

E. RFI: Radio-frequency interference.

1.3 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. 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.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with requirements in this Section.

F. Devices for Owner-Furnished Equipment:

1. Receptacles: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

G. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Essential Electrical System: Red.

H. Wall Plate Color: For plastic covers, match device color.

I. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.3 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

A. Duplex Receptacles, 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498 and FS W-C-596.

B. Weather-Resistant Duplex Receptacle, 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498.
4. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

2.4 USB RECEPTACLES

A. USB Charging Receptacles:

1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
2. USB Receptacles: Dual and quad, USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
3. Standards: Comply with UL 1310 and USB 3.0 devices.

2.5 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A:

1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Type: Feed through.
4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

2.6 SPD RECEPTACLES, 125 V, 20 A

A. Duplex SPD Receptacles, 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding. Integral SPD in line to ground, line to neutral, and neutral to ground. LED indicator light.
2. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
3. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
4. Configuration: NEMA WD 6, Configuration 5-20R.
5. Standards: Comply with NEMA WD 1, UL 498, UL 1449, and FS W-C-596

2.7 TWIST-LOCKING RECEPTACLES

A. Twist-Lock, Single Receptacles, 120 V, 20 A:

1. Configuration: NEMA WD 6, Configuration L5-20R.
2. Standards: Comply with UL 498.

B. Twist-Lock, Single Receptacles, 250 V, 20 A:

1. Configuration: NEMA WD 6, Configuration L6-20R.
2. Standards: Comply with UL 498.

2.8 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector, heavy-duty grade.

B. Configuration: NEMA WD 6, Configurations as shown on drawings.

C. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.

D. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

E. Standards: Comply with FS W-C-596.

2.9 CORD AND PLUG SETS

A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.

B. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.

C. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.10 TOGGLE SWITCHES, 120/277 V, 20 A

A. Single-Pole Switches, 120/277 V, 20 A:

1. Standards: Comply with UL 20 and FS W-S-896.

B. Two-Pole Switches, 120/277 V, 20 A:

1. Comply with UL 20 and FS W-S-896.

C. Three-Way Switches, 120/277 V, 20 A:

1. Comply with UL 20 and FS W-S-896.

D. Four-Way Switches, 120/277 V, 20 A:

1. Comply with UL 20 and FS W-S-896.

E. Key-Operated, Single-Pole Switches, 120/277 V, 20 A:

1. Factory-supplied key in lieu of switch handle.
2. Comply with UL 20 and FS W-S-896.

2.11 DIMMERS

A. Wall-Box Dimmers:

1. Description: Modular, full-wave, solid-state dimmer switch with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
2. Control: Continuously adjustable slider; with single-pole or three-way switching.
3. Standards: Comply with UL 1472.
4. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

    a. 600 W; dimmers shall require no derating when ganged with other devices.

5. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
6. LED Lamp Dimmer Switches: Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.12 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: As selected by Architect.
3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant thermoplastic with lockable cover.

2.13 FLOOR SERVICE FITTINGS

A. Flush-Type Floor Service Fittings:

1. Description: Type: Modular, flush-type, dual-service units suitable for wiring method used, with cover flush with finished floor.
2. Compartments: Barrier separates power from voice and data communication cabling.
3. Service Plate and Cover: Rectangular, solid brass with satin finish.
4. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
5. Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for twisted pair cable.

2.14 PREFABRICATED MULTIOUTLET ASSEMBLIES

A. Description: Two-piece surface metal raceway, with factory-wired multioutlet harness.

B. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

D. Multioutlet Harness:

1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
2. Receptacle Spacing: as indicated on drawings.
3. Wiring: No. 12 AWG solid, Type THHN copper, single circuit.

2.15 SERVICE POLES

A. Dual-Channel Service Poles:

1. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
2. Poles: Nominal 2.5-inch- square cross-section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.
3. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
4. Material: Aluminum.
5. Finishes: Manufacturer's standard painted finish and trim combination.
6. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, balanced twisted pair data communication cables.
7. Power Receptacles: Two duplex, 20-A, straight-blade receptacles complying with requirements in this Section.
8. Data Communication Outlets: Four RJ-45 jacks.

2.16 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: White.
2. SPD Devices: Blue.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors online and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with white-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

B. Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using a self-adhesive label.

3.4 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.

2. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

D. Tests for Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units, replace with new ones and retest as specified above.

E. Wiring device will be considered defective if it does not pass tests and inspections.

END OF SECTION 26 27 26

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 28 13
FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in enclosed switches.

1.2 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

1.3 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.4 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Bussmann, Inc.
2. Ferraz Shawmut, Inc.
3. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

1. Motor Branch Circuits: Class RK5, time delay.
2. Other Branch Circuits: Class RK5, time delay.
3. Control Circuits: Class CC, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Non-fusible switches.

1.2 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Horsepower ratings (as appropriate).

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.

2. Altitude: Not exceeding 6600 feet.

1.6 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances per NEC and for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide:

1. Square D; a brand of Schneider Electric.
2. Eaton Electrical Inc.; Cutler-Hammer.
3. General Electric Company; GE.
4. Siemens Energy & Automation, Inc.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provide rejection of other fuse types. Provide switch with Class R fuses.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.
5. Internal Barrier Kit: Provides additional barrier that helps prevent accidental contact with live parts.
6. Cover Viewing Window: Provides window over the blades to allow visual verification of ON-OFF status.

2.2 NONFUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide:

1. Square D; a brand of Schneider Electric.
2. Eaton Electrical Inc.; Cutler-Hammer.
3. General Electric Company; GE.
4. Siemens Energy & Automation, Inc.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.
4. Internal Barrier Kit: Provides additional barrier that helps prevent accidental contact with live parts.
5. Cover Viewing Window: Provides window over the blades to allow visual verification of ON-OFF status.

2.3 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1
2. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Furnish and install where required by code; by equipment manufacturer requirements; by Authority Having Jurisdiction.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    b. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 26 28 16

SECTION 26 32 13.13
DIESEL EMERGENCY ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes packaged diesel engine generators for emergency use with the following features:

1. Diesel engine.
2. Diesel fuel-oil system.
3. Control and monitoring.
4. Generator overcurrent and fault protection.
5. Generator, exciter, and voltage regulator.
6. Load banks.
7. Outdoor engine generator enclosure.
8. Vibration isolation devices.
9. Finishes.

B. Related Requirements:

1. Section 26 36 00 "Transfer Switches" for transfer switches, including sensors and relays to initiate automatic starting and stopping signals for engine generators.

1.2 DEFINITIONS

A. EPS: Emergency power supply.

B. EPSS: Emergency power supply system.

C. Operational Bandwidth: The total variation, from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include thermal damage curve for generator.
3. Include time-current characteristic curves for generator protective device.
4. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
6. Include airflow requirements for cooling and combustion air in cubic feet per minute at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 deg F. Provide Drawings indicating requirements and limitations for location of air intake and exhausts.

7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installer, manufacturer and testing agency.

B. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

C. Field quality-control reports.

D. Warranty: For special warranty specified in this section.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For engine generators to include in emergency, operation, and maintenance manuals.

1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
2. Operating instructions laminated and mounted adjacent to generator location.
3. Training plan.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. An authorized representative who is factory certified, trained and approved by manufacturer.
2. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
3. Access to Service & Parts: Manufacturer selected by the installer shall maintain a factory-owned or factory authorized parts and service distribution center within 50 miles of the Project Site. A ‘sales office’ will not qualify as a service & parts facility.
4. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

C. Manufacturer Qualifications: The manufacturer shall be in the business of manufacturing power generation systems under an ISO-9001 certification process for over 10 years. The manufacturer shall employ service, engineering and parts staff within a factory-owned or authorized service center, within 50 miles of Project site.

D. Manufacturer Service Qualifications: The manufacturer shall have a service center within a 50 mile distance from the project site. This service center shall have been in the business of providing engineering, application support, on-site rental, start-up & commissioning, replacement parts and labor for the maintenance and repair of power generation system equipment; for a minimum of 10 years.

E. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer so as to provide only one source of warranty and responsibility.

F. 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.

G. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

H. Noise Emission: Comply with applicable state and local government requirements due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators in addition to associated auxiliary components that fail in materials or workmanship within specified warranty period. The warranty shall include parts, labor, prompt field service, pick-up and delivery.

1. Warranty Period: Five (5) years from date of Substantial Completion.
2. Generator tank and housing shall be warranted to be free of rust for the warranty period.

1.9 PROJECT CONDITIONS

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

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

1.10 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Provide for vibration isolation as per manufacturer’s recommendations.

1.11 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by direct employees of manufacturer's factory service organization. Include quarterly exercising under building load to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide all parts and supplies at no additional charge to the owner, with the exception of fluids in the commissioning of this maintenance. Parts shall be OEM, the same as those used in the manufacture and installation of original equipment. Provide a full load bank test prior to the end of the first year warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Generac Power Systems, Inc.
2. Cummins Power Generation.
3. Caterpillar, Inc.; Electric Power Division.
4. Kohler Power Systems.
5. MTU Onsite Energy Corporation.

B. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. B11 Compliance: Comply with B11.19.

B. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 99.
4. Comply with NFPA 110 requirements for Level 1 EPSS.

C. UL Compliance: Comply with UL 2200.

D. Engine Exhaust Emissions: Comply with EPA Tier 2 requirements and applicable state and local government requirements.

E. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator, including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

F. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5 to 104 deg F.
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level to 1000 feet.

G. Unusual Service Conditions: Engine generator equipment and installation are required to operate under the following conditions:

1. High salt-dust content in the air due to sea-spray evaporation.

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. EPSS Level: Level 1 as defined in NFPA 110. Failure of the equipment to perform could result in loss of human life or serious injuries.

D. EPSS Class: Engine generator shall be classified as a Class 72.

E. Service Load: 250 kW/313kVA. Provide with upsized alternator as required by calculations.

F. Power Factor: 0.8, lagging.

G. Frequency: 60 Hz

H. Voltage: 208 V ac.

I. Phase: Three-phase, four-wire wye

J. Induction Method: Turbocharged.

K. Governor: Adjustable isochronous, with speed sensing.

L. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

M. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.
2. Nameplates: For each major system component to identify manufacturer's name and address, model and serial number of components.

N. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage, from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency, from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.4 DIESEL ENGINE

A. Fuel: ASTM D 975 diesel fuel oil, Grade 2-D S15.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: Engine or skid mounted.

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and with UL 499.

E. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant, from cold start to 110 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant-system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.

    a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and non-collapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 25 feet from exhaust discharge after installation is complete shall be 78 dBA or less.

G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

H. Starting System: 24V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle, with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Adequate capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.

5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type. Unit shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F to 140 deg F to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
    f. Enclosure and Mounting: NEMA 250, Type 1 wall-mounted cabinet.

2.5 DIESEL FUEL-OIL SYSTEM

A. Main fuel supply shall be from sub-base fuel day tank.

1. Provide 372-gallon sub-base fuel day tank.

B. Comply with NFPA 30.

C. Piping: Fuel-oil piping shall be Schedule 40 black steel, complying with requirements in Section 23 11 13 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

D. Fuel Filtering: Remove water and contaminants larger than 1 micron.

E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Subbase-Mounted, Double-Wall, Fuel-Oil Day Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:

1. Fuel-Tank Capacity: 372 usable gallons
2. Leak detection in interstitial space.
3. Vandal-resistant fill cap.
4. Containment Provisions: Comply with requirements of authorities having jurisdiction.

5. Tank shall be from a manufacturer with a minimum of (10) ten years of experience in the design and construction of UL listed sub base fuel tanks.
6. Tank shall be constructed in accordance with UL-142., FDEP as applicable, NFPA 30, NFPA 37 and NFPA 110.
7. Sub base fuel tank shall be rectangular in shape and include reinforced steel box channel for generator support. Exterior of tank shall be pressure washed with an iron phosphate solution and interior shall be treated with rust preventative.
8. Sub base tank testing shall consist of primary and secondary tank containment basin and shall be pressurized at 3-5 psi and leak checked to ensure integrity of sub base weld seams per UL-142 standards. Fuel containment basin shall be welded steel and be sized as a minimum of 110% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture. Provide a fuel containment basin leak detector switch.
9. Sub base tank fittings shall include the following:

    a. Appropriately sized NPT fuel supply.
    b. Fuel return fitting
    c. 2” NPT for normal vent
    d. NPT for emergency vent, sized as appropriate
    e. 2” NPT for manual fill.
    f. NPT for level gauge, sized as appropriate.
    g. 3/8” NPT basin drain
    h. 2” NPT for level alarm.
    i. NPT fitting for leak detection alarm

10. Provide a direct-reading fuel level gauge.

2.6 CONTROL AND MONITORING

A. Automatic-Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

B. Manual-Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

C. Provide minimum run time control set for 30 minutes, with override only by operation of a remote emergency-stop switch.

D. Comply with UL 508A.

E. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.

F. Control and Monitoring Panel:

1. Digital controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
2. Instruments: Located on the control and monitoring panel and viewable during operation.

    a. Engine lubricating-oil pressure gage.
    b. Engine-coolant temperature gage.
    c. DC voltmeter (alternator battery charging).
    d. Running-time meter.
    e. AC voltmeter, for each phase**.**
    f. AC ammeter, for each phase.
    g. AC frequency meter.
    h. Generator-voltage-adjusting rheostat.

3. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication as required by NFPA 110 for Level 1 system, including the following:

    a. Cranking control equipment.
    b. Run-Off-Auto switch.
    c. Overcrank alarm.
    d. Overcrank shutdown device.
    e. High engine temperature pre-alarm.
    f. High engine temperature shutdown device.
    g. Low lube oil pressure pre-alarm.
    h. Low lube oil pressure shutdown device.
    i. Overspeed alarm.
    j. Overspeed shutdown device.
    k. Low-fuel main tank alarm.

        1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for the duration required for the indicated EPSS class.

    l. Coolant low-level alarm.
    m. Coolant low-level shutdown device.
    n. EPS supplying load alarm.
    o. Control switch not in automatic position alarm.
    p. Battery high-voltage alarm.
    q. Low-cranking voltage alarm.
    r. Battery-charger ac failure alarm.
    s. Battery low-voltage alarm.
    t. Lamp test.
    u. Contacts for local and remote common alarm.
    v. Low starting air pressure alarm.
    w. Low starting hydraulic pressure alarm.
    x. Air shutdown damper alarm when used.
    y. Remote emergency stop activated alarm.
    z. Coolant high-temperature prealarm.
    aa. Coolant high-temperature alarm.
    bb. Coolant low-temperature alarm.
    cc. Coolant high-temperature shutdown device.
    dd. Low water temperature alarm.
    ee. Generator overcurrent-protective-device not-closed alarm.
    ff. Generator overload alarm.
    gg. Generator not in auto alarm.

G. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated

H. Connection to Datalink:

1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.

I. Remote Alarm Annunciator: Comply with NFPA 99. An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

a. Overcrank alarm.
b. Overcrank shutdown device.
c. High engine temperature pre-alarm.
d. High engine temperature shutdown device.
e. Low lube oil pressure pre-alarm.
f. Low lube oil pressure shutdown device.
g. Overspeed alarm.
h. Overspeed shutdown device.
i. Low-fuel main tank alarm.
j. Coolant low-level alarm.
k. Coolant low-level shutdown device.
l. EPS supplying load alarm.
m. Control switch not in automatic position alarm.
n. Battery high-voltage alarm.
o. Low-cranking voltage alarm.
p. Battery-charger ac failure alarm.
q. Battery low-voltage alarm.
r. Lamp test.
s. Contacts for local and remote common alarm.
t. Low starting air pressure alarm.
u. Low starting hydraulic pressure alarm.
v. Air shutdown damper alarm when used.
w. Remote emergency stop activated alarm.
x. Coolant high-temperature prealarm.
y. Coolant high-temperature alarm.
z. Coolant low-temperature alarm.
aa. Coolant high-temperature shutdown device.
bb. Low water temperature alarm.
cc. Generator overcurrent-protective-device not-closed alarm.
dd. Generator overload alarm.
ee. Generator not in auto alarm.

2. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

J. Remote Emergency-Stop Switch: Switch: Surface mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.

1. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.

1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.
2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide six-lead alternator.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Drip proof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
2. Maintain voltage within 20 percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within 15 percent and stabilize at rated frequency within five seconds.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: 12 percent, maximum.

2.9 OUTDOOR ENGINE GENERATOR ENCLOSURE

A. Description: Vandal-resistant, sound-attenuating, weatherproof aluminum housing, wind resistant up to 200 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

1. Sound Attenuation Level: Minimum 25 dBa reductions at 1 meter.

B. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads.

C. Hinged Doors: With padlocking provisions.

D. Load Center: 208V, 3-phase, 100A main circuit breaker type, for generator auxiliary loads.

E. Space Heater: Thermostatically controlled and sized to prevent condensation.

F. Lighting: Provide weather-resistant LED lighting with 50-fc average maintained.

G. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.

H. Muffler Location: Within enclosure.

I. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow. Shall prevent entry of exterior dust, birds and rodents while permitting air circulation when engine in not running.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

J. Interior Lights with Switch: Factory-wired, vapor-proof luminaires within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

K. Convenience Outlets: Factory-wired GFCI. Arrange for external electrical connection.

L. Vertical air intake and vertical radiator air discharge plenums. Top of housing facilitates diesel engine exhaust cap.

M. Under no circumstances shall the generator's operational accessories share the same circuit with the enclosure lighting and enclosure convenience power outlet.

2.10 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Standard neoprene separated by steel shims.
2. Shore A Scale Durometer Rating: 45.
3. Number of Layers: Two.
4. Minimum Deflection: 1 inch.

B. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.11 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.12 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Test generator, exciter, and voltage regulator as a unit.
3. Full-load run.
4. Maximum power.
5. Voltage regulation.
6. Transient and steady-state governing.

7. Single-step load pickup.
8. Safety shutdown.
9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
10. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.

C. Equipment Mounting:

1. Install packaged engine generators on concrete equipment base provided by others.
2. Coordinate size and location of concrete base with structural engineer and concrete contractor. Cast anchor-bolt inserts into bases.
3. Install generator in a walk-in enclosure with elastomeric isolator pads having a minimum deflection of 1 inch on concrete base. Secure enclosure to anchor bolts installed in concrete base.

D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

E. Exhaust System: Install Schedule 40 black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.

1. Piping materials and installation requirements are specified in Section 23 21 13 "Hydronic Piping."
2. Install flexible connectors and steel piping materials according to requirements in Section 23 21 16 "Hydronic Piping Specialties."
3. Insulate muffler/silencer and exhaust system components according to requirements in Section 23 07 19 "HVAC Piping Insulation."

F. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.

G. Fuel Piping:

1. Copper and galvanized steel shall not be used in the fuel-oil piping system.

H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow space for service and maintenance.

C. Connect cooling-system water piping to engine generator and heat exchanger with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Connect fuel piping to engines with a gate valve and union and flexible connector.

F. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.4 IDENTIFICATION

A. Identify system components according to Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and in "Visual and Mechanical Inspection" and "Electrical and Mechanical Tests" subparagraphs below, as specified in the NETA ATS. Certify compliance with test parameters.

a. Visual and Mechanical Inspection:

1) Compare equipment nameplate data with Drawings and the Specifications.
2) Inspect physical and mechanical condition.

3) Inspect anchorage, alignment, and grounding.
4) Verify that the unit is clean.

b. Electrical and Mechanical Tests:

1) Perform insulation-resistance tests according to IEEE 43.

a) Machines Larger Than 200 hp: Test duration shall be 10 minutes. Calculate polarization index.
b) Machines 200 hp or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.

2) Test protective relay devices.
3) Verify phase rotation, phasing, and synchronized operation as required by the application.
4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
5) Perform vibration test for each main bearing cap.
6) Conduct performance test according to NFPA 110.
7) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
c. Verify acceptance of charge for each element of the battery after discharge.
d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases and verify that performance is as specified.
7. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
8. Noise-Level Tests: Measure A-weighted level of noise emanating from engine generator installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet from edge of the generator enclosure, and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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

I. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component, indicating satisfactory completion of tests.

K. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels, so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's authorized service representative. Include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer's authorized replacement parts and supplies.

3.7 DEMONSTRATION

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

END OF SECTION 26 32 13.13

SECTION 26 36 00
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes automatic transfer switches rated 600 V and less, including the following:

1. Remote annunciator system.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
2. Include material lists for each switch specified.
3. Single-Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer-authorized service representative.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

a. Features and operating sequences, both automatic and manual.
b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications:

1. Member company of NETA.

a. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA ICS 1.

C. Comply with NFPA 99.

D. Comply with NFPA 110.

E. Comply with UL 1008 unless requirements of these Specifications are stricter.

F. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, unless otherwise indicated.

G. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
2. Short-time withstand capability for three cycles.

H. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

I. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

J. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be

mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

K. Service-Rated Transfer Switch:

1. Comply with UL 869A and UL 489.
2. Provide terminals for bonding the grounding electrode conductor to the grounded service conductor.
3. In systems with a neutral, the bonding connection shall be on the neutral bus.
4. Provide removable link for temporary separation of the service and load grounded conductors.
5. Surge Protective Device: Service rated.
6. Service Disconnecting Means: Externally operated, mechanically actuated.

L. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

M. Neutral Terminal: Solid and fully rated unless otherwise indicated.

N. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

O. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable shrinkable sleeve markers at terminations. Color-coding and wire and cable markers are specified in Section 26 05 53 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
4. Accessible via front access.

P. Enclosures: General-purpose NEMA 250, Type 1 complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

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

1. Caterpillar, Inc.; Electric Power Division.
2. Cummins Power Generation.
3. Generac Power Systems, Inc.
4. Kohler Power Systems.
5. MTU Onsite Energy Corporation.

B. Comply with Level 1 equipment according to NFPA 110.

C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switch Action: Double throw; mechanically held in both directions.
2. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
3. Conductor Connectors: Suitable for use with conductor material and sizes.
4. Material: Hard-drawn copper, 98 percent conductivity.
5. Main and Neutral Lugs: Compression type.
6. Ground bar.
7. Connectors shall be marked for conductor size and type according to UL 1008.

D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.

1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
2. Fully automatic break-before-make operation with center off position.

E. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

F. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

G. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

H. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.
2. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is unavailable.

2.3 TRANSFER SWITCH ACESSORIES

A. Remote Annunciator System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches.
3. Annunciation panel display shall include the following indicators:

    a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    b. Switch position.
    c. Switch in test mode.
    d. Failure of communication link.

4. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

    a. Indicating Lights: Grouped for each transfer switch monitored.
    b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
    c. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
    d. Lamp Test: Push-to-test or lamp-test switch on front panel.

B. Remote Annunciator and Control System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Include the following functions for indicated transfer switches:

    a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    b. Indication of switch position.
    c. Indication of switch in test mode.
    d. Indication of failure of digital communication link.
    e. Key-switch or user-code access to control functions of panel.

f. Control of switch-test initiation.
g. Control of switch operation in either direction.

3. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically shall revert to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
4. Remote Annunciation and Control Panel: Solid-state components. Include the following features:

a. Controls and indicating lights grouped together for each transfer switch.
b. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
c. Digital Communication Capability: Matched to that of transfer switches supervised.
d. Mounting: Flush, modular, steel cabinet unless otherwise indicated.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008, performed on representative devices, for emergency systems. Include results of test for the following conditions:

a. Overvoltage.
b. Undervoltage.
c. Loss of supply voltage.
d. Reduction of supply voltage.
e. Alternative supply voltage or frequency is at minimum acceptable values.
f. Temperature rise.
g. Dielectric voltage-withstand; before and after short-circuit test.
h. Overload.
i. Contact opening.
j. Endurance.
k. Short circuit.
l. Short-time current capability.
m. Receptacle withstand capability.
n. Insulating base and supports damage.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Install transfer switches on cast-in-place concrete equipment base(s).
2. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

3. Provide workspace and clearances required by NFPA 70.

B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.

C. Identify components according to Section 26 05 53 "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

E. Comply with NECA 1.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Wiring Method: Install cables in raceways except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

F. Route and brace conductors according to manufacturer's written instructions. Do not obscure manufacturer's markings and labels.

G. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches in length.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing equipment, test for compliance with requirements according to NETA ATS.
2. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with Drawings and Specifications.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and required clearances.
d. Verify that the unit is clean.

e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
f. Verify that manual transfer warnings are attached and visible.
g. Verify tightness of all control connections.
h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:

1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

i. Perform manual transfer operation.
j. Verify positive mechanical interlocking between normal and alternate sources.
k. Perform visual and mechanical inspection of surge arresters.
l. Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

3. Electrical Tests:

a. Perform insulation-resistance tests on all control wiring with respect to ground.
b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
c. Verify settings and operation of control devices.
d. Calibrate and set all relays and timers.
e. Verify phase rotation, phasing, and synchronized operation.
f. Perform automatic transfer tests.
g. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.
2) Engine start sequence.
3) Time delay on transfer.
4) Alternative source voltage-sensing and frequency-sensing relays.
5) Automatic transfer operation.
6) Interlocks and limit switch function.
7) Time delay and retransfer on normal power restoration.
8) Engine cool-down and shutdown feature.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.
b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
    g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Transfer switches will be considered defective if they do not pass tests and inspections.

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

G. Prepare test and inspection reports.

H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Coordinate this training with that for generator equipment.

END OF SECTION 26 36 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 41 13
LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes lightning protection system for ordinary structures.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
2. Include raceway locations needed for the installation of conductors.
3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
4. Include roof attachment details, coordinated with roof installation.
5. Calculations required by NFPA 780 for bonding of metal bodies.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lightning protection cabling attachments to roofing systems and accessories.
2. Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.
3. Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.

B. Qualification Data: For Installer.

C. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For lightning protection system to include in maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations. Comply with requirements of Section 01 78 39 "Project Record Documents."
b. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.

B. Completion Certificate:

1. UL Master Label Certificate.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: LPI Master Installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Advanced Lightning Technology, Ltd.
2. East Coast Lightning Equipment Inc.
3. ERICO; a brand of nVent.
4. Harger Lightning & Grounding.
5. Heary Bros. Lightning Protection Co. Inc.
6. Independent Protection Co.
7. National Lightning Protection.
8. Preferred Lightning Protection.
9. Robbins Lightning, Inc.
10. Thompson Lightning Protection, Inc.

2.2 PERFORMANCE REQUIREMENTS

A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I buildings.

B. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.3 MATERIALS

A. Air Terminals:

1. Aluminum unless otherwise indicated.

B. Class 1 Main Conductors:

1. Aluminum: 98,600 circular mils in diameter.

C. Ground Rods:

1. Material: Copper-clad steel.
2. Diameter: 3/4 inch.
3. Rods shall be not less than 120 inches long.

D. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches in radius and narrow loops.

C. Conceal conductors within normal view from exterior locations at grade within 200 feet of building. Comply with requirements for concealed systems in NFPA 780.

1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
2. Install conduit where necessary to comply with conductor concealment requirements.
3. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

D. Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor.

3.2 CONNECTIONS

A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.

B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Perform inspections as required to obtain a UL Master Label for system.
2. Perform inspections to obtain an LPI certification.

B. Prepare test and inspection reports and certificates.

END OF SECTION 26 41 13

SECTION 26 43 13
SURGE PROTECTION DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

1.2 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

1.3 SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

B. Field quality-control reports.

C. SPD manufacturer shall provide UL 3rd Edition documentations as part of the submittal.

D. Sample Warranty: Manufacturer's warranty statement.

E. Maintenance Data: For SPDs to include in maintenance manuals.

1.4 PROJECT CONDITIONS

A. Service Conditions: Rate SPD devices for continuous operation under the following conditions unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F.
3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet above sea level.

1.5 COORDINATION

A. Coordinate location of field-mounted SPD devices to allow adequate clearances for maintenance.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period. Warranty shall cover unlimited replacement of SPD modules during the warranty period.

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

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Comply with UL 1449 3rd edition.

D. Comply with NFPA 780 & UL96A Lighting Protection System Master Label.

E. MCOV of the SPD shall be the nominal system voltage.

2.2 SERVICE ENTRANCE OR TRANSFER SWITCH SUPPRESSOR

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

1. LEA International.
2. PQ Protection.
3. Advanced Protection Technologies Inc (APT).
4. Emerson.

B. SPDs: Comply with UL 1449, Type 1.

1. SPDs shall have the following features and accessories:

1. Integral disconnect switch.
2. Modular design (with field replaceable modules redundant per phase and redundant per mode).
3. SPD's shall be mounted external to the panel; internally mounted SPD's are not acceptable.
4. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
5. Indicator light display for protection status.
6. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
7. Surge counter.
8. Audible alarm, with silencing switch to indicate when protection has failed.

C. Comply with UL 1283.

D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 300 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

E. Protection modes and UL 1449 VPR (clamping voltage) for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V or 800 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V or 1200 V for 208Y/120 V.
3. Line to Line: 2000 V for 480Y/277 V or 1000 V for 208Y/120 V.

F. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 1000 V.
3. Line to Line: 1000 V.

G. SCCR: Equal or exceed 200 kA.

H. Inominal Rating: 20 kA.

2.3 PANEL SUPPRESSORS

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

1. LEA International.
2. PQ Protection.
3. Advanced Protection Technologies Inc (APT).
4. Emerson.

B. SPDs: Comply with UL 1449, Type 2.

1. SPDs shall have the following features and accessories:

1. Compact, non-modular design.
2. SPD's shall be mounted external to the panel; internally mounted SPD's are not acceptable.
3. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
4. Indicator light display for protection status.
5. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
6. Audible alarm, with silencing switch to indicate when protection has failed.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than the following:

1. 100A – 400A branch panelboards: 100kA.
2. 600A – 1200A distribution panelboards: 200kA.
3. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V or 800 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
3. Neutral to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
4. Line to Line: 2000 V for 480Y/277 V or 1200 V for 208Y/120 V.

E. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 700 V.
3. Neutral to Ground: 700 V.
4. Line to Line: 1200 V.

F. SCCR: Equal or exceed 200 kA.

G. Inominal Rating: 20 kA.

2.4 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

B. Outdoor Enclosures: NEMA 250, Type 4.

2.5 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

2.6 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD (sized per manufacturer's recommendation) as required to comply with the UL listing of the SPD.

C. Verify all voltages before connecting to avoid injury and damage to equipment.

D. The SPDs shall be installed external to switchboard, distribution panel, or branch panel.

E. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

F. Refer to manufacturer's installation manual for further details.

G. Use crimped connectors and splices only. Wire nuts are unacceptable.

H. Wiring:

1. Power Wiring: Comply with wiring methods in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
2. Controls: Comply with wiring methods in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

2.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

2.8 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

2.9 DEMONSTRATION

A. Train owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 26 43 13

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, lamps, ballasts, LEDs, and drivers.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. HID: High-intensity discharge.

D. LER: Luminaire efficacy rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.3 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Energy-efficiency data.
3. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

B. Installation instructions.

C. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

D. Energy Efficiency: Meet applicable requirements of the IECC/DOE Energy Code and ANSI/ASHRAE/IESNA 90.1-2010 Energy Standard.

1.5 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.6 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Ten year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Ambient Temperature: 41 to 104 deg F.

1. Relative Humidity: Zero to 95 percent.

B. Altitude: Sea level to 1000 feet.

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.

c. CCT and CRI.

C. Recessed luminaires shall comply with NEMA LE 4.

D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

2.3 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Steel:

1. ASTM A 36/A 36M for carbon structural steel.
2. ASTM A 568/A 568M for sheet steel.

C. Stainless Steel:

1. Manufacturer's standard grade.
2. Manufacturer's standard type, ASTM A 240/240 M.

D. Galvanized Steel: ASTM A 653/A 653M.

E. Aluminum: ASTM B 209.

2.4 EMERGENCY POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate fluorescent lamp(s) or LEDs continuously at an output of 1400 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Nightlight Connection: Operate lamp or LEDs continuously.
3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.5 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Operating at nominal voltage of 120 V ac or 277 V ac.
2. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
3. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

2.6 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.7 LUMINAIRE SUPPORT

A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

B. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge.

E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Lighting fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
2. Install lamps in each luminaire.

C. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

D. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.

1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.
2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

E. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Identify light fixtures that are fed by an emergency generator with a label stating “EMERGENCY SERVICE”. Place label on the ballast near the wire terminations.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 26 51 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior luminaires with LEDs and drivers.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. HID: High-intensity discharge.

D. LER: Luminaire efficacy rating.

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.3 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

1. Basic wind speed for calculating wind load for poles 50 feet high or less is 110 mph. (Verify local requirements.)

a. Wind Importance Factor: 1.0.
b. Minimum Design Life: 25 years.
c. Velocity Conversion Factors: 1.0.

1.4 SUBMITTALS

A. Product Data: For each luminaire and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with IEEE C2, "National Electrical Safety Code."

D. Comply with NFPA 70.

E. Energy Efficiency: Meet applicable requirements of the IECC/DOE Energy Code and ANSI/ASHRAE/IESNA 90.1-2010 Energy Standard.

1.6 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: One year with extended warranties provided by manufacturers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

1. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
2. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

    a. Color: As selected by Architect from manufacturer's full range.

N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

a. Color: As selected by Architect from manufacturer's full range.

O. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp and ballast characteristics:

a. "USES ONLY" and include specific lamp type.
b. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
d. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
f. CCT and CRI for all luminaires.

2.3 LED LUMINAIRES

A. General: Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.

B. Material and specifications for each luminaire are as follows:

1. Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
2. Each luminaire shall be rated for a minimum operational life of 50,000 hours at an average operating time of 11.5 hours per night at 40ºC (104ºF).
3. The rated operating temperature range shall be -30°C (-22ºF) to +40°C (104ºF).
4. Each luminaire is capable of operating above 104°F (40°C), but not expected to comply with photometric requirements at elevated temperatures.
5. Photometry must be compliant with IESNA LM-79 and shall be conducted at 25°C ambient temperature.
6. Each luminaire shall meet all parameters of this specification throughout the minimum operational life when operated at the average nighttime temperature.
7. The individual LEDs shall be constructed such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
8. Luminare shall be constructed such that LED modules may be replaced or repaired without replacement of whole luminaire.
9. Each luminaire shall be listed with Underwriters Laboratory, Inc. under UL1598 for luminaires, or an approved equivalent standard from a nationally recognized testing laboratory.

2.4 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.

2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

G. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

2.5 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.

B. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.

1. Shape: As selected by Architect from manufacturer's full range.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
2. Finish: Same as pole and luminaire.

F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

G. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

a. Color: As selected by Architect from manufacturer's full range.

2.6 PRESTRESSED CONCRETE POLES

A. Poles: Comply with ASTM C 1089.

1. Shape: Square, tapered.
2. Mounting Provisions: Embedded.
3. Finishing: Capped at top and plugged at bottom. Seat each reinforcing strand with epoxy adhesive.
4. Grounding: Continuous copper ground wire cast into pole. Terminate at top of pole.
5. Raceway: Smooth, internal, and not less than 3 inches in diameter.

B. Concrete: Minimum 28-day compressive strength of 7000 psi.

C. Cured with wet steam and aged for a minimum of 15 days prior to installation.

D. Reinforcement: Pre-stressing strand, 270 K, complying with ASTM A 416/A 416M.

E. Surface Treatment: Hard, nonporous, and resistant to water, frost, and road and soil chemicals; and shall have a maximum water-absorption rate of 3 percent.

F. Finish Texture: Standard form.

G. Fasteners: Stainless steel, size and type as determined by manufacturer. Compatible with poles and standards as well as the substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.

H. Nameplate: Aluminum cast into pole wall at approximately 5 feet above ground line, listing name of manufacturer, Project identifier, overall height, and approximate weight.

I. Pole Brackets: Comply with ANSI C136.31.

2.7 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.
2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
3. Install base covers unless otherwise indicated.
4. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

1. Make holes 6 inches in diameter larger than pole diameter.
2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days, and finish in a dome above finished grade.
3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
4. Cure concrete a minimum of 72 hours before performing work on pole.

F. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

G. Raise and set poles using web fabric slings (not chain or cable).

3.3 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 26 05 33 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundations.

3.5 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

END OF SECTION 26 56 00

Division 27

Communications

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 27 00 00
COMMUNICATIONS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The Premise Distribution System (PDS) is to include all equipment, materials, labor and documentation as required to provide, install and test a complete system as described herein.

B. System to include but not be limited to:

1. Telephone Service Entrance Pathway: Raceway from point of telephone utility connection at property line to building service terminal backboard.
2. Backbone Pathway: Conform to EIA/TIA 569 using conduit, cable tray, backboards, etc. as indicated.
3. Horizontal Pathway: Conform to EIA/TIA 569, using raceway, bridle rings, sleeves, backboards, and cabinets as indicated.
4. Premises Wiring: Complete from Premise Distribution System Equipment to each outlet, and between each building using wire and cable as specified.
5. Outlets: Complete as specified.
6. Raceways, outlet boxes, cabinets, identification, etc.: Conform to applicable sections in these specifications. Provide/install complete with all required basic materials.
7. Terminal backboards and/or cabinets.
8. Equipment cabinets/racks.
9. Frames and termination hardware.
10. Horizontal cables.
11. Backbone copper and fiber optic cables (inter-building and intra-building.)
12. Terminal blocks
13. Patch boards.
14. Cross-connect cables.
15. Terminations.
16. Surge suppression.
17. Fireproofing.

C. Special Requirements for Cable Routing and Installation:

1. The majority of PDS wiring in this building will be installed above ceilings. All communications cabling used throughout this project shall comply with the requirements as outlined in the National Electric Code (NEC) Article 800. All cabling shall bear CMP and/or appropriate markings for the environment in which they are installed.
2. Sealing of openings between floors, through rated fire and smoke walls, existing or created by this contractor for cable pass through shall be the responsibility of the PDS contractor. Sealing material and application of this material shall be accomplished in such a manner that is acceptable to the local fire and building authorities having jurisdiction over this work. Creation of such openings as are necessary for cable passage between locations as shown on the drawings shall be the responsibility of the (PDS) Premise Distribution Wiring System contractor's work. Any openings created by or for this contractor and left unused shall also be sealed as part of this work.

3. The PDS 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.

D. Applicable requirements of General Requirements/Provisions shall be considered a part of this section and shall have the same force as if printed herein full. In addition, all information related to communications infrastructure that is documented in the architectural, structural, mechanical, and electrical drawings/documents shall be included as part of the Communications documents.

E. Related Specifications:

1. Division 26
2. Division 27
3. Division 28

1.2 QUALITY ASSURANCE

A. Specifications, Standards and Codes: All work shall be in accordance with the following:

1. American Society for Testing and Materials (ASTM)
2. EIA/TIA 568 Commercial Building Telecommunications Wiring Standard.
3. EIA/TIA 569 Commercial Building Standard for Telecommunication Pathways and Spaces.
4. EIA/TIA-606 - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
5. EIA/TIA-607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.
6. EIA/TIA-492 AAAA - Detail Specification for 62.5 Micrometer Core Diameter/125 Micrometer Cladding Diameter Class 1a Multimode, Graded Index Optical Waveguide Fibers.
7. EIA/TIA TSB-36 - Technical Systems Bulletin, Additional Transmission Specifications for Unshielded Twisted Pair Cables.
8. EIA/TIA TSB-40-A - Technical Systems Bulletin, Additional Transmission Specifications for Unshielded Twisted Pair Connecting Hardware.
9. EIA/TIA 606 - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
10. FCC: Federal Communication Commission Part 68 as modified by Wiring Docket 88-57.
11. BICSI - Building Industry Consulting Service International, Inc.
12. Florida DMS/DOC - General Facility Requirements for Telecommunications Systems.
13. LPC - Lightning Protection Code (NFPA-780).
14. NEC - National Electrical Code (NFPA-70).
15. NFPA 262-1985 - National Fire Prevention Association, 1470 Atlantic Avenue, Boston, MA 02210.
16. IEEE 802.3 - Institute of Electrical and Electronics Engineers LAN Standard for Ethernet.
17. UL Listed - Underwriters Laboratories Listed.
18. UL Certified - UL's LAN Cable Certification Program.
19. UL 910 - Test for Flame Propagation and Smoke Density Values for Electrical and Optical Fiber Cables Used in Spaces Transporting Environmental Air.
20. UL 1666 - Test for Flame Propagation Height of Electrical and Optical Fiber Cables Installed Vertically in Shafts.
21. UL 1449-1987 - Standard for Safety, Transient Voltage Surge Suppressors.

22. UL 497, UL 497A, UL 497B.
23. ANSI - American National Standards Institute.
24. NEMA - National Electrical Manufacturer's Association.
25. The BICSI Telecommunications Distribution Methods Manual (TDMM) and Appendix).
26. In the event of conflicts, the more stringent provisions shall apply.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and indicated.

1.3 SCOPE

A. The work to be done under this section of the Specifications shall include the furnishing of labor, material, equipment and tools required for the complete installation of the work indicated on the Drawings or as specified herein.

B. All materials, obviously a part of the Communications Infrastructure and necessary to its proper operation, but not specifically mentioned or shown on the Drawings, shall be furnished and installed without additional charge.

C. The Drawings and Specifications are complementary to each other and what is called for by one shall be as binding as if called for by both. If a discrepancy exists between the Drawing and Specifications, the higher cost shall be included, and the engineer shall be notified of the discrepancy.

1.4 WORK INCLUDED

A. The Communications Infrastructure installed and work performed under this Division of the Specifications shall include but not necessarily be limited to the following:

1. Voice/Data Cabling Infrastructure
2. CATV Cabling Infrastructure System
3. Audio-Visual Systems
4. Overhead Sound System
5. Communications conduits, sleeves, J-hooks, raceways, cable tray, racks, cabinets and equipment mounting boards
6. Grounding and Bonding of Communications Equipment

1.5 DEFINITIONS

A. Terms: The following definitions of terms supplement those of the General Requirements and are applicable to Division 27 – Communications.

1. Communications Equipment Room (CER). The "communications equipment room" (CER) is a dedicated room for termination of cable and to house the primary voice and data equipment. NOTE: The COMMUNICATIONS EQUIPMENT ROOM (CER) normally houses the MAIN DISTRIBUTION FRAME (MDF) and Local Exchange Carrier (LEC) equipment demarcation point.
2. Communications Closet (CC). A "communications closet" (CC) is a dedicated room for termination of cable and to house secondary voice and data equipment. NOTE: The COMMUNICATIONS CLOSET (CC) normally houses an INTERMEDIATE DISTRIBUTION FRAME (IDF).

3. Communications Panel (CP). A wall mounted cabinet for termination of cable and to house secondary and data equipment. NOTE: The COMMUNICATIONS PANEL (CP) may serve as an INTERMEDIATE DISTRIBUTION FRAME (IDF).
4. Intermediate Distribution Frame (INTERMEDIATE DISTRIBUTION FRAME (IDF). The "intermediate distribution frame" (INTERMEDIATE DISTRIBUTION FRAME (IDF) is an equipment rack(s) and/or cabinet(s) housing secondary (intermediate) voice and data equipment.
5. Main distribution Frame (MDF). The "main distribution frame" (MDF) is an equipment rack(s) and/or cabinet(s) housing the primary voice and data equipment.
6. Horizontal Pathways. Horizontal pathways are facilities for the installation of communication cable from the communications closet to the work area communications outlet. Horizontal pathways encompass under floor, access floor, conduit, tray and wire-way, ceiling, sleeves, perimeter facilities and applicable fireproofing.
7. Backbone Pathways. Backbone pathways consist of intra-building and inter-building pathways. The term backbone replaces rise, house and building-tie cable terminology. Backbone pathways may be either vertical or horizontal. Inter-building backbone pathways extend between buildings. Intra-building backbone pathways are contained within a building.
8. Intra-building pathways consist of conduit, sleeves or slots, and trays, within a building, and provide the means for placing backbone cables from:
9. COMMUNICATIONS EQUIPMENT ROOM (CER) to COMMUNICATIONS CLOSET (CC)
10. COMMUNICATIONS CLOSET (CC) or COMMUNICATIONS PANEL (CP) to COMMUNICATIONS CLOSET (CC) or COMMUNICATIONS PANEL (CP)
11. Inter-building pathways interconnect separate buildings such as in campus environments. These consist of underground pathways.
12. Provide: As used herein shall mean “furnish, install and test (if applicable) complete.”
13. Infrastructure: As used herein shall mean cable, conduit, raceway, cable tray or j-hooks with all required boxes, fittings, connectors, and accessories; completely installed.
14. Work: As used herein shall be understood to mean the materials completely installed, including the labor involved.

1.6 DRAWINGS

A. Drawings are generally diagrammatic and show the arrangement and location of pathways, outlets, support structures and equipment. The Contractor shall carefully investigate the structural and finish conditions affecting his work and arrange his work accordingly. Should conditions on the job make it necessary to make adjustments to pathways or materials, the Contractor shall so advise the Engineer and secure approval before proceeding with such work.

B. Where exact locations are required by equipment for stubbing-up and terminating conduit concealed in floor slabs, the Contractor shall request shop drawings, equipment location drawings, foundation drawings, and any other data required by him to locate the concealed conduit before the floor slab is poured.

C. Materials, equipment or labor not indicated but which can be reasonably inferred to be necessary for a complete installation shall be provided. Drawings and Specifications do not undertake to indicate every item of material, equipment, or labor required to produce a complete and properly operating installation.

D. The right is reserved to make reasonable changes in locations of equipment indicated on Drawings prior to rough-in without increase in contract cost.

E. The Contractor shall not reduce the size or number of conduit runs indicated on the Drawings without the written approval of the Engineer.

F. Any work installed contrary to Contract Drawings shall be subject to change as directed by the Engineer, and no extra compensation will be allowed for making these changes.

G. The location of equipment, support structures, outlets, and similar devices shown on the Drawings are approximate only. Do not scale Drawings. Obtain layout dimensions for equipment from Architectural plans unless indicated on Communications plans.

H. Schematic diagrams shown on the Drawings indicate the required functions only. The technology of a particular manufacturer may be used to accomplish the functions indicated without exact adherence to the schematic Drawings shown. Additional labor and materials required for such deviations shall be furnished at the Contractor's expense.

I. Verify the ceiling type, ceiling suspension systems, and clearance above hung ceilings prior to ordering cabling and associated hardware. Notify the Engineer of any discrepancies.

J. Review all architectural drawings for modular furniture.

K. Portions of these Drawings and Specifications are abbreviated and may include incomplete sentences. Omissions of words or phrases such as “the Contractor shall,” “shall be,” “as indicated on the Drawings,” “In accordance with,” “a,” “the” and “all are intended” shall be supplied by inference.

1.7 SUBMITTALS

A. Submit for approval, details of all materials, equipment and systems to be furnished. Work shall not proceed without the Owner and/or the Project Manager's approval of the submitted items. Four (4) copies of the following shall be submitted:

1. Submittals for individual systems and equipment assemblies that consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered, reviewed or stored, and such submittals will not be returned except at the request and expense of the Contractor.
2. Shop drawings shall include equipment racks, patch panels, termination blocks, connection details, rack mounting details and any other details not included in the construction drawings.

B. Submit under provisions of Section.

C. Shop Drawings: Submit typical outlet wiring diagram, plan of building(s) and site showing pathways with cable noted, detail drawings of each of the facilities terminal boards/cabinets, and equipment rack elevations to include all MAIN DISTRIBUTION FRAME (MDF) and INTERMEDIATE DISTRIBUTION FRAME (IDF) locations.

D. Product Data: Submit for wiring, outlets, devices, and accessories.

E. Qualifications: Submit qualifications of system installer.

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

G. Test Equipment: Submit a letter, signed by an officer of the company, that indicates what test equipment the company owns and shall use for accomplishment of the test procedures required in these specifications.

H. Submit labeling scheme and sample of label.

I. Contractor shall submit test reports, manufacturer's specification sheets and any other information necessary to determine compliance with material and equipment specifications described herein.

J. For Surge Suppressors submit product data as follows:

1. Dimensions.
2. Means of mounting.
3. Compliance with UL Standards referenced.
4. Compliance with IEEE Standards referenced.
5. Design type (Hybrid, MOV, etc.)
6. Size of wire leads.
7. Warranty.
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.

K. Submittals that do not include all items as listed above, and as required elsewhere in these specifications shall, at the discretion of the Engineer, shall not be reviewed and shall be returned to the Contractor for re-submittal.

L. Any materials and equipment listed that are not in accordance with Specification requirements may be rejected.

M. The approval of material, equipment, systems and shop drawings is a general approval subject to the Drawings, Specifications and verification of all measurements at the job. Approval does not relieve the Contractor from the responsibility of shop drawing errors. The Contractor shall carefully check and correct all shop drawings prior to submission for approval.

1.8 QUALITY ASSURANCE

A. Equipment and materials required for installation under these Specifications shall be the current model and new (less than one [1] year from the date of manufacture), unused and without blemish or defect.

B. Equipment shall bear labels attesting to Underwriters Laboratories, where subject to label service. Manufacturers of equipment and materials pertinent to these items shall have been engaged in the manufacture of said equipment a minimum of three (3) years and, if so directed by the Owner, be able to furnish proof of their ability by submitting affidavits and descriptive data about their product including size and magnitude comparable to requirements specified herein.

C. Perform work governed by local telephone utility (service only) in accordance with telephone utility's rules and regulations.

1.9 QUALIFICATIONS

A. Manufacturer: Systimax unless noted otherwise.

B. Supplier: Authorized distributor of specified manufacturer with minimum 5 years documented experience.

C. Installer: The PDS Contractor shall have total responsibility for the coordination and installation of the work shown and described in the Drawings and Specifications. The Contractor shall be a company specializing in the design, fabrication and installation of integrated communications systems. Communications Systems specified shall be installed under the direction of a qualified Contractor.

D. The PDS Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The Contractor must be Avaya certified for optical and metallic premise distribution installations. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and metallic premise distribution systems and have personnel who are adequately trained in the use of such tools and equipment.

E. Company or person installing system must specialize in installing premises wiring with minimum three years documented experience. Company and person installing must be Avaya certified. Contractors shall provide to Owner all documentation and certifications of employees and subcontractors.

F. Installer shall be a State Certified Low Voltage Electrical Contractor.

G. A resume of qualification shall be submitted with the Contractor's proposal indicating the following:

1. A list of recently completed PDS projects of similar type and size with contact names and telephone numbers for each.
2. A list of test equipment proposed for use in verifying the installed integrity of metallic and fiber optic cable systems on this project.
3. A technical resume of experience for the Contractor's Engineer and on-site installation foreman who will be assigned to this project.
4. Similar documentation for any sub-contractor who will assist the PDS Contractor in performance of this work.

H. Contractor must employ at least one (1) full-time Registered Communications Distribution Designer (RCDD). The RCDD shall be a W2 employee and not a subcontractor. The contractor shall also have a BICSI Certified Technician on site during installation.

1.10 EXTRA MATERIALS

A. Provide 5% spare modular jack inserts.

B. Provide 5% spare termination blocks of each kind.

C. Provide 5% spare dust covers of each type.

D. Provide 15% spare patch cables and pigtail assemblies of each kind.

1.11 COORDINATION WITH OTHER TRADES

A. The Contractor shall coordinate communications work with that of other sections as required ensuring that the entire communications work will be carried out in an orderly, complete and coordinated fashion.

1.12 SITE INVESTIGATION

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions that may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems, shall be restored to their original condition before the completion of this project.

1.13 PERMITS

A. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Owner all certificates of said inspection issued by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Where equipment is identified by manufacturer and catalog number, it shall be as the base of requirements for quality and performance. Where manufacturers for equipment are identified by name, the Contractor may submit for approval, similar equipment of other manufacturers as substitution. The Engineer's decision as to whether the submitted equipment is acceptable shall be final and binding.

B. All changes necessary to accommodate the substituted equipment shall be made at the Contractor's expense, and shall be as approved by the Engineer. Detailed drawings indicating the required changes shall be submitted for approval at the time the substitution is requested.

C. If substitutions are made in lieu of device specified; form, dimension, design and profile shall be submitted to the Engineer for approval.

D. Submit request for approval of substitute materials in writing to the Architect at least ten days prior to bid opening.

2.2 MATERIALS

A. All materials used in this work shall be new and shall bear the inspection label of Underwriters' Laboratories Inc. or certification by other recognized laboratory.

B. The published standards and requirements of the Telecommunications Industries Association (TIA), National Electrical Manufacturers Association (NEMA), the American National Standard Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), and the American Society of Testing Materials (ASTM), are made a part of these Specifications and shall apply wherever applicable.

C. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.

D. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer or partner manufacturers that offer a certified solution.

E. Components of an assembled unit need not be products of the same manufacturer, but must offer a certified end-to-end solution.

F. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.

G. Components shall be compatible with each other and with the total assembly for the intended service.

H. The contractor shall be responsible for the delivery, receipt, and safe storage on site of all communications materials and equipment to the job site until the job is completed and the owner accepts the equipment or installation. Replace any damaged materials or equipment.

I. Records shall be kept of all materials and equipment delivered to the job site in the form of shipping manifests, bills of laden or signed receipts.

J. At the end of the installation all remaining communications materials and equipment will be inventoried and turned over to the owner.

PART 3 - EXECUTION

3.1 EXAMINATION OF CONDITIONS

A. Prior to the start of work, the Contractor shall carefully inspect the installed work of other trades and verify that such work is complete to the point where installation may properly commence. Start of work indicates acceptance of conditions.

B. Install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.

C. In the event of a discrepancy, immediately notify the Project Manager and the General Contractor.

D. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

3.2 PROTECTION OF SYSTEMS AND EQUIPMENT

A. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.

B. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering the sides with securely fastened protective rigid or flexible waterproof coverings.

C. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum cleaned both inside and outside before testing, operating or painting.

D. As determined by the Owner or Engineer, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Owner or Engineer shall be final.

E. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with the same quality of paint and workmanship as used by the manufacturer.

3.3 ACCESS TO EQUIPMENT

A. Equipment shall be installed in location and manner that will allow convenient access for maintenance and inspection.

B. Working spaces shall be not less than specified in the National Electrical Code (NEC) for voltages specified.

C. Where the Project Manager determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the Project Manager, at no additional cost to the Owner. “Conveniently accessible” is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.

3.4 CLEANING

A. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by communications work.

B. Remove dust and debris from interiors and exteriors of electrical equipment. Clean accessible current carrying elements prior to being energized.

3.5 COMPLETION

A. General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.

B. Results Expected: Systems shall be complete and operational and controls shall be set and calibrated. Labeling, testing, start-up and cleaning work shall be complete.

C. Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this Specification shall be delivered to the Owner.

3.6 TESTING AND VERIFICATION

A. See specific Division 27 sections for testing parameters of sub-systems.

B. The Contractor shall verify that requirements of this Specification are met. Verification shall be through a combination of analyses, inspections, demonstrations and tests, as described below.

C. Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the Specifications. Inspection may require moving or partially disassembling the item to accomplish the verification, included as part of the work at no additional cost to the Owner.

D. The Contractor shall verify by formal demonstrations or tests that the requirements of this Specification have been met. The Contractor shall demonstrate that the communications systems, components and subsystems meet Specification requirements in the "as-installed" operating environment during the "System Operation Test." Even though no formal environmental testing is required, the Contractor shall measure and record temperature, humidity and other environmental parameters and the environmental conditions, which were encountered during the "System Operation Test."

E. The Contractor shall carefully plan and coordinate the final acceptance tests so that tests can be satisfactorily completed. The Contractor shall provide necessary instruments, labor and materials required for tests, including the equipment manufacturer's technical representative and qualified technicians in sufficient numbers to perform the tests within a reasonable time period.

F. The Contractor shall satisfy all items detailed in the final acceptance check-off list (punch list). The list shall be a complete representation of specified installation requirements. At the time of final acceptance punch list items shall be corrected until the system is found to be acceptable to the Owner and the Project Manager.

G. After the Contractor systems have been installed and tested, the completed test plan shall be signed by the Communications Contractor Project Manager and submitted for approval.

END OF SECTION 27 00 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 27 05 00
COMMON WORK RESULTS FOR COMMUNICATIONS 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.

B. Related Specifications:

1. Division 26
2. Division 27
3. Division 28

1.2 SUMMARY

A. Section Includes:

1. Communications equipment coordination and installation.
2. Sleeves for pathways and cables.
3. Sleeve seals.
4. Grout.
5. Common communications installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR PATHWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular pace between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide duct name or designation or comparable product by one of the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

3. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of pathway or cable.
4. Pressure Plates: Stainless steel. Include two for each sealing element.
5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 27 05 00

SECTION 27 05 26
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 26 – Electrical and Division, 27 – Communications, shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Grounding and Bonding for Communications Systems.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer's specifications.

1.3 WORK INCLUDED

A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Grounding Busbar Manufacturer(s):

1. Harger
2. B-Line
3. Chatsworth Products, Inc.

2.2 GROUNDING CONDUCTORS

A. Grounding Conductor:

1. Construction shall be Type THHN copper conductors, insulated with heat and moisture resistant PVC over which a UL listed jacket is applied.
2. Jacket color shall be green.

2.3 GROUNDING LUGS

A. Grounding Lugs and Hardware:

1. Grounding lugs shall be 2-hole and installed with a crimper that when properly executed the die of the crimper impresses the die # on the lug base. All lugs shall be sleeved with clear heat-shrink to allow for inspection of the crimp. Silicon bronze or stainless steel bolts and washers shall be used to install lugs to equipment. Exothermic welding is also allowed.

2.4 GROUNDING BUSBARS

A. Grounding Busbar:

1. The grounding busbar shall be made of 1/4" thick solid copper.
2. The grounding busbar shall be installed with minimum clearance, 1" offsets and 1-1/2" insulators.
3. The grounding busbar shall accommodate 2-hole compression lugs.
4. The grounding busbar shall meet or exceed ANSI/TIA-607-B requirements.

PART 3 - EXECUTION

3.1 GROUNDING

A. The facility shall be equipped with a Communications Bonding Backbone (TBB). This backbone shall be used to ground all communications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA-607-B Telecommunications Bonding and Ground Standard.

B. The main entrance facility/equipment room in each building shall be equipped with a telecommunications main grounding busbar (TMGB). Each telecommunications room (TR) shall be provided with a telecommunications ground busbar (TGB). The TMGB shall be connected to the building electrical entrance grounding facility.

C. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the MC/IC/TC shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression lugs.

D. All wires used for communications grounding purposes shall be identified with a green insulation. Non-insulated wires shall be identified at each termination point with a wrap or green tape. All cables and busbars shall be identified and labeled in accordance with the ANSI/TIA-606-A.

E. See Section 27 05 43 - Underground Ducts and Raceways for Communications Systems for underground duct and raceway systems ground requirements.

3.2 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION 27 05 26

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 27 05 28
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 26 – Electrical and Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Pathways for Communications Systems.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer's specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Cable Hanger Manufacturer(s):

1. Erico Products – Caddy
2. Panduit
3. Or Approved Equal

B. Approved Tie Wrap/Velcro Strap Manufacturer(s):

1. Thomas & Betts
2. Panduit
3. Or Approved Equal

2.2 CONDUIT

A. Rigid and Intermediate (RGI) Conduit:

1. Rigid conduit, intermediate conduit, couplings, locknuts, bushings, elbows and connectors shall be standard thread. All materials shall be steel. Set screw or non-threaded fittings are not permitted.

B. Non-Metallic (PVC) Conduit:

1. Non-metallic conduit shall be heavy wall, Schedule 80 PVC.
2. Couplings and connectors for non-metallic conduit shall be of the same material and be the product of the same manufacturer of the conduit furnished.

C. Electrical Metallic Tubing (EMT):

1. Electrical metallic tubing (EMT), couplings and connectors shall be steel. Malleable iron, pressure-cast or die-cast fittings are not permitted.
2. Fittings for 2" EMT and smaller shall be steel set screw type, except where otherwise noted. Fittings for 2.5" and larger shall be steel set screw type with two (2) screws for connectors and four (4) screws for couplings. All connectors shall be insulated throat type.

D. Electrical Non-Metallic Tubing (ENT):

1. ENT shall be a pliable, non-metallic raceway manufactured of the same PVC material used for rigid non-metallic conduit.
2. Fittings and outlet boxes shall be designed for use with ENT and listed by Underwriters Laboratories.

E. Conduit Support:

1. Individual conduit hangers shall be galvanized spring steel specifically designed for the purpose and sized appropriately for the conduit type and diameter. Support individual conduits 1-1/2 inch and smaller with 1/4 inch threaded steel rods and use 3/8 inch rods for 2 inch and larger.
2. Conduit support channels shall be 14 gauge galvanized (or equivalent treatment) channel sized for the amount of conduit to be supported. Channel suspension shall be 3/8" threaded steel rods. Attach suspension rods to structure with swivel type connectors. Conduit straps shall be spring steel type compatible with channel.
3. Conduit straps shall be single hole cast metal type or two hole galvanized metal type. Conduit clamps shall be spring steel type for use with exposed structural steel.

F. Innerduct / Inner-Conduit Channel:

1. Innerduct shall be corrugated plastic equipped with pull-string or mule tape.
2. Inner-conduit channel (MaxCell) shall be 3-channel with each channel equipped with mule tape.
3. See Drawings for innerduct / inner-conduit channel (MaxCell) details.

2.3 METALLIC COMMUNICATIONS OUTLET BOXES

A. Metallic outlet boxes and device covers shall be galvanized steel not less than 1/16" thick.

B. The dimensions of the metallic outlet box shall be 4" x 4" square with a minimum depth of 2-1/8".

C. Metallic outlet boxes shall be equipped with single device covers (or two-device covers where needed). Where installed in plaster, gypsum board, etc., covers shall be raised to compensate for the thickness of the wall finish.

D. Where metallic outlet boxes are to be empty for future use, blank coverplates shall be used.

2.4 NON-METALLIC COMMUNICATIONS OUTLET BOXES

A. The non-metallic outlet box shall be thermoplastic and be rated according to the space it occupies.

B. The dimensions of the non-metallic outlet box shall be approximately 4" x 4" square with a minimum depth of 2-1/8".

C. Non-metallic outlet boxes shall be equipped with single device covers. Covers shall be raised to compensate for the thickness of the wall finish.

D. Where non-metallic outlet boxes are to be empty for future use, blank faceplates shall be used.

2.5 PULL BOXES

A. Pull boxes shall be constructed of galvanized steel with flat, removable covers fastened with plated steel screws.

B. Pull boxes shall be equipped with keyhole screw slots in the cover to permit removal of the cover without extracting the screws.

C. Pull boxes shall have provisions for grounding.

2.6 CABLE HANGERS

A. J-Hooks:

1. J-hooks shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables. J-hook shall be UL Listed.
2. J-hooks shall have flared edges to prevent damage while installing cables.
3. J-hooks sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
4. Amount of cables shall not exceed capacity. Install per manufacturer's specifications.

B. Adjustable Non-Continuous Cable Support Sling:

1. Constructed from steel and woven laminate; sling length can be adjusted to hold up to 425 4-pair balanced twisted pair cables; rated for indoor use in non-corrosive environments. Rated to support Category 5 and higher cable, or optical fiber cable. Cable support sling shall be UL Listed.
2. Adjustable non-continuous cable support sling shall have a static load limit of 100 lbs.

3. Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces.

2.7 TIE WRAPS AND VELCRO STRAPS

A. Tie Wraps and Velcro Straps:

1. Cables shall be fastened to support structures with tie wraps/Velcro straps.
2. Tie wraps/Velcro straps installed in air handling spaces must be plenum rated.

a. Non-plenum Tie Wrap color shall be black.
b. Plenum Tie Wrap color shall be red.
c. Non-plenum Velcro strap color shall be black.
d. Plenum Velcro strap color shall be red.

PART 3 - EXECUTION

3.1 PENETRATIONS

A. Holes through concrete and masonry in new and existing structures shall be cut with a diamond core drill or concrete saw upon approval of the structural engineer of record for the base of building. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed, except where permitted by the Project Manager as required by limited working space. X-ray all floor penetrations accordingly.

B. Holes shall be located so as not to affect structural sections such as ribs or beams.

C. Holes shall be laid out in advance. The Project Manager shall be advised prior to drilling through structural sections, for determination of proper layout.

D. Structural Penetrations: Where conduits, wireways and other raceways pass through fire partitions, fire walls or walls and floors provide a code compliant effective barrier against the spread of fire, smoke and gases.

E. All penetrations where conduit is not used shall be sleeved.

F. No gaps or rough edges shall be allowed between wall and conduit/sleeve.

3.2 CONDUIT SYSTEM

A. Conceal all conduits, except in unfinished spaces such as equipment rooms or as indicated by symbol on the Drawings.

B. Leave all empty conduits with a 200 pound test nylon cord pull line.

C. Flattened, dented, or deformed conduits are not permitted and shall be removed and replaced.

D. Fasten conduit support device to structure with wood screws on wood, toggle bolts on hollow masonry, anchors as specified on solid masonry or concrete, and machine bolts, clamps, or spring steel clips, on steel.

E. Install conduit with wiring, including homeruns as indicated on the Drawings. Any change resulting in a savings in labor or materials is to be made only in accordance with a contract change. Deviations shall be made only where necessary to avoid interferences and when approved by Engineer by written authorization.

F. Conduit shall be run parallel or at right angles to existing walls, ceilings, and structural members.

G. Attach backbone conduits larger than one-inch trade diameter to or from structure on intervals not exceeding twelve feet with conduit beam clamps, one-hole conduit straps or trapeze type support.

H. Where conduits must pass through structural members obtain approval of Architect.

I. Install all conduits or sleeves penetrating or routed within rated firewalls or fire floors to maintain fire rating of wall or floor. Conduit shall not be installed in rated floors or walls if it compromises or violates the fire rating of floor or wall. Refer to architectural documents.

J. Provide expansion and deflection coupling where conduit passes over a building expansion joint.

K. Service entrance conduits and feeder conduits in direct contact with earth shall be schedule 40, heavy wall PVC. All service entrance conduit elbows shall be galvanized rigid steel. Service entrance conduits installed exposed or concealed in walls or above ceilings shall be galvanized rigid steel (G.R.S.) or intermediate metal conduit (IMC). Service entrance conduits shall be installed "outside" of the building as defined by the N.E.C. Provide concrete encasement where required or as indicated on Drawings.

L. All other conduit, unless specified herein, shall be electrical metallic tubing (EMT). PVC conduit is not allowed in exposed or concealed areas, but only within concrete.

M. Conduit Installations Within Slab/Floor:

1. Conduit shall be run following the most direct route between points.
2. Conduit shall not be installed in concrete where the outside diameter is larger than 1/3 of the slab thickness.
3. Conduits shall not be installed within shear walls unless specifically indicated on the Drawings. Conduit shall not be run directly below and parallel with load bearing walls.
4. Protect each metallic conduit installed in concrete slab or conduits 1-1/2 inch and smaller passing through a concrete slab against corrosion where conduit enters and leaves concrete by wrapping conduit with vinyl all-weather electrical tape.
5. Protect all conduits entering and leaving concrete floor slabs from physical damage during construction.
6. Provide expansion fittings in all conduits where length or run exceeds 200 feet or where conduits pass through building expansion joints.
7. Install all conduits penetrating or routed within rated fire floors to maintain the fire rating of the floor. Conduit shall not be installed in rated floors or walls if it compromises or violates the fire rating of floor or wall. Refer to architectural documents.
8. Conduits installed within concrete floor slabs which are in direct contact with grade or which penetrate the building roof shall be galvanized rigid steel (G.R.S.), intermediate metal conduit (I.M.C.) or Schedule 40, heavy wall PVC.

N. Communications cables shall not occupy conduits with power cables.

O. Metallic conduits shall be grounded in accordance with ANSI/TIA-607-B.

P. Conduit runs shall not have more than two (2) 90-degree bends between pull points.

Q. Communications conduit system shall contain no condulets (also known as an LB).

R. Rigid metal conduit (RMC) or intermediate metal conduit (IMC) shall be used for entrance conduits that exceed 50 feet into the building.

S. Horizontal Conduits:

1. Support horizontal conduits at intervals not exceeding ten feet and within three feet of each outlet, junction box, backboard, enclosure or cabinet. Support conduits from structural steel members with spring steel type or beam conduit clamps and to non-metallic structural members with one-hole conduit straps. For exposed conduits and where conduits must be suspended below structure, single conduit runs shall be supported from structure by hanger rod and conduit clamp assembly, and multiple conduits shall be supported by trapeze type support suspended from structure. Do not attach conduits to ceiling suspension system channels or suspension wires.
2. For runs that total more than 100 feet in length, insert pull boxes so that no segment between boxes exceeds the 100 feet limit.

3.3 COMMUNICATIONS OUTLET BOXES

A. Exact locations of the outlet boxes shall be coordinated with the electrical contractor and other trades.

B. The approximate locations of the outlets are indicated on the Drawings. The exact locations shall be determined at the building. The right is reserved to change, without additional cost, the exact location of any outlet, a maximum of 10' before it is permanently installed.

C. Orientation of outlet boxes (horizontal or vertical) shall be as indicated on the architectural elevations.

D. Install all outlet boxes in finished areas flush with the wall. Maintain 1/4" or less space between outlet box front and finished wall surface.

E. Outlet boxes shall be firmly anchored in place and shall not depend on the coverplate to hold it secure to the wall.

F. Outlet boxes installed back-to-back in fire-rated walls shall be separated horizontally by a minimum of 12".

3.4 PULL BOXES

A. Pull boxes shall be secured, independent of the conduit entries into the box. Pull boxes shall be secured to the building structure. In ceiling applications, pull boxes shall not be supported with ceiling wires.

B. Conduits entering pull boxes shall connect to pull boxes using die-cast zinc connectors.

C. Pull boxes shall be free from burrs, dirt and debris.

D. Pull boxes shall be installed in accordance with ANSI/TIA-569-B.

E. Pull boxes shall be grounded in accordance with ANSI/TIA-607-B.

3.5 CABLE HANGERS

A. Installation and configuration shall conform to the requirements of ANSI/TIA-568-C.0, ANSI/TIA-568-C.1 & ANSI/TIA-569-B, NFPA 70 (National Electrical Code), applicable local codes, and to the manufacturer's installation instructions.

B. Install cables using techniques, practices, and methods that are consistent with Category 6 or higher requirements and that supports Category 6 or higher performance of completed and linked signal paths, end to end.

C. Install cables without damaging conductors, shield, or jacket.

D. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.

E. Pull cables without exceeding cable manufacturer's recommended pulling tensions. Use pulling means that will not damage media.

F. Do not exceed load ratings specified by manufacturer.

G. Adjustable non-continuous support sling shall have a static load limit of 100 lbs.

H. To avoid electromagnetic interference (EMI), pathways shall provide minimum clearances of four feet from motors or transformers, one foot from conduit and cables used for electrical power distribution, and five inches from fluorescent lighting. Pathways shall cross perpendicular to fluorescent lighting and electrical power cables or conduits.

3.6 TIE WRAPS AND VELCRO STRAPS

A. Tie wraps/Velcro straps shall be installed around cables at intervals of 12" minimum.

B. Tie wraps shall secure cables to cable trays using an "X" pattern.

C. Do not over-cinch cables.

3.7 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION 27 05 28

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 27 05 53
IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the equipment and execution requirements relating to Identification for Communications Systems.

C. Equipment specifications, general considerations, and guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 WORK INCLUDED

A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 – PRODUCTS

2.1 LABELING REQUIREMENTS

A. Labeling shall be done in accordance with the recommendations made in the ANSI/TIA-606-A document, manufacturer's recommendations and best industry practices.

B. All indoor labels shall be clear with black text. All outdoor labels will be designed for outdoor use. Manhole labels will be metal tags.

C. Termination racks and equipment cabinets shall be labeled according to the drawings with engraved black on white plastic nameplates at the top of the enclosure. ¼” font minimum.

D. Patch panels shall be labeled according to the drawings and industry standards to identify each panel starting from the top of the enclosure. ¼” font

E. All cabinet mounted communications equipment shall be labeled. ¼” font

F. All cables shall be labeled with machine generated, 12 pt font, wrap around self protecting labels.

G. A total of three no less then (3) labels per horizontal cable are required at the following intervals: 6" from termination of cable at outlet and block/patch panel and at all penetrations.

H. Labeling scheme shall be alphanumeric and approved by project manager.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide and generate all labeling per EIA/TIA 606-A (no labels will be furnished by the Owner).

B. Labels shall be developed and printed using a software program.

C. Software program and all in-puts shall be turned over to the Owner at the end of the project.

3.2 INSTALLATION

A. All labels shall be installed straight.

B. Provide labels at locations as indicated on the drawings and as follows:

1. Outlet face plates
2. Outlet cable inside box
3. Outlet cable at rear of patch panel
4. Port on front of patch panel
5. Front of fiber patch panel
6. Fiber optic cable at rear of fiber optic patch panel
7. Riser cables whenever exposed on minimum 10' intervals
8. Riser cable at point of termination
9. Cables at voice blocks
10. Ends of any cable put in place that is not terminated
11. On front of racks and cabinets frames
12. Patch cords (both ends)
13. Cables in manholes stating serving and destination locations
14. All spaces, pathways, termination hardware, grounding system and equipment shall be labeled.
15. On ceiling grid below location where an “above ceiling” outlet is installed.

3.3 TEMPORARY LABELS

A. Provide temporary labels on all outlet cables as it is roughed-in.

3.4 TEXT SIZE AND INFORMATION

A. Text size should be as large and as bold as possible.

B. Exact text required information is shown on the drawings.

C. All outlet, outlet cables, and riser cables labels shall contain:

1. Designation number
2. "To" and "From" information

3. Room numbers

3.5 LABELING REFERENCE CHARTS

A. Contractor to provide a labeling reference chart(s) indicating the following:

1. Voice riser termination of pairs at each end
2. Voice outlet cable pair termination at the voice block
3. Data patch panel outlet port termination
4. Fiber riser terminations at each end

3.6 AS BUILT DOCUMENTATION

A. Contractor to add labeling information to as built drawings at end user locations.

END OF SECTION 27 05 53

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 27 08 00
COMMISSIONING OF COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the equipment and execution requirements relating to Commissioning of Communications.

C. Equipment specifications, general considerations, and guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - TESTING

2.1 TESTING REQUIREMENTS

A. General:

1. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA-568-C.0, ANSI/TIA-568-C.1, and/or ANSI/TIA-1152. All conductors/strands of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors/strands in all cables installed.

B. Copper Testing:

1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category 6 performance. Horizontal balanced twisted pair cabling shall be tested using a level IIe, III, or IV test unit for category 6 performance compliance.
2. Continuity - Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail as indicated by the test unit and referenced to the appropriate cable identification number and circuit or pair

number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.

3. Length - Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA-568-C.2 Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.
4. Approved tester is as follows:
   Fluke DTX

C. Fiber Testing:

1. All fiber testing shall be performed on all fibers in the completed end-to-end system. There shall be no splices unless clearly defined in the Specifications and/or Drawings. These tests also include continuity checking of each fiber.
2. Multimode:

   a. Test the optical fiber cable bi-directionally and uni-directionally with a Fluke DTX. Fiber must be tested at both 850nm and 1300nm. Maximum attenuation dB/Km @ 850nm/1300nm shall be 3.5/1.5. Maximum attenuation per connector pair shall be .75 dB. Attenuation testing shall be performed with a stable launch condition using a one-meter or two-meter jumper, wrapped around a mandrel sized according to fiber type, to attach the light source to the cable plant. Fiber jumper shall be wrapped around mandrel no less than five (5) times. The jumper-mandrel assembly shall remain connected to the light source after calibration and the power meter moved to the far end using a new jumper to take measurements. Test set-up and performance shall be conducted in accordance with ANSI/TIA-568-C.3, and to the manufacturer's application guides.

3. Singlemode:

   a. Test the optical fiber cable bi-directionally with an OTDR and uni-directionally with a power meter/light source. Fiber must be tested at both 1310nm and 1550nm. Maximum attenuation dB/Km @ 1310nm/1550nm shall be 0.5/0.5 for outside plant and 1.0/1.0 for inside plant. Maximum attenuation per connector pair shall be .75 dB. Attenuation testing shall be performed with a stable launch condition using one-meter or two-meter jumpers to attach the test equipment to the cable plant. The light source shall be left in place after calibration and the power meter moved to the far end to take measurements. Test set-up and performance shall be conducted in accordance with ANSI/TIA-568-C.3, and to the manufacturer's application guides.

4. Approved optical fiber test equipment manufacturers are as follows:

   a. Power Meters & Light Sources
      Optical Wavelength Laboratories (OWL)
      Photonix
      Fluke
      Agilent
   b. Optical Time Domain Reflectometers (OTDR)
      GN Nettest

Agilent
Fluke
Anritsu
Fiber Instrument Sales - Model # OVHQUAD

D. Test Results:

1. Test documentation shall be provided in 3 hard copies and 3 electronic copies on disk as part of the as-built package. The disk shall be clearly marked on the outside front cover with the words “Project Test Documentation,” the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair (or strand) and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.
2. The field test equipment shall meet the requirements of ANSI/TIA-568-C.2, ANSI/TIA-568-C.3, and/or ANSI/TIA-1152.
3. Three bound printouts generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package. These CDs shall contain the electronic equivalent of the test results as defined by the Specification and be of a format readable from Microsoft Word.
4. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

PART 3 - DOCUMENTATION, AS-BUILTS, TRAINING AND RECORDS

3.1 DOCUMENTATION AND AS-BUILTS

A. Submit under provisions of the General and Supplemental Conditions of the Contract and Section.

B. Record actual locations and sizes of pathways, outlets, terminal boards, etc.

C. Record actual type and size of cables installed.

D. Record "to and from" locations coordinated with cable labeling for all cables at each terminal board or cabinet.

E. Cross-connects "to and from location" terminations for each Telecom and/or Communication Closet.

F. 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. All documentation must be provided on CD-ROM. All documentation must be in AutoCad drawing format.

G. Cable Route Diagram: Provide locations and routes of "as-built" cable system and include:

1. End points.
2. Fiber routing.
3. Splice points.
4. Patch panels.
5. Terminations (connector type).
6. Cable lengths (include slack).
7. Location of surge suppressors.

H. The Contractor shall provide and maintain at the site a set of prints on which shall be accurately shown the actual installation of all work under this section, indicating any variation from contract drawings, including changes in pathways, sizes, locations and dimensions. All changes shall be clearly and completely indicated as the work progresses.

I. Progress prints shall be available for inspection by the Owner or any of his representatives and may be used to determine the progress of communications infrastructure work.

J. At the completion of the work, prepare a new set of as-built drawings, of the work as actually noted on the marked-up prints, including the dimensioned location of all pathways.

K. Furnish as-built drawings and documentation to the Project Manager. As-built drawings shall be generated in AutoCad 2006 or later. Submit 3 copies of as-built drawings electronically on C.D. and hard copy.

3.2 OPERATIONS AND MAINTENANCE MANUAL

A. After completion of the work, the Contractor shall furnish and deliver to the Engineer three (3) copies of a complete Operations & Maintenance Manual. A system wiring diagram shall be furnished for each separate system.

B. The manual shall be subdivided into separate sections with tab dividers to identify subsystems of the integrated system. Reference appropriate Specification sections.

C. Provide the following additional information for each electronic system. Information shall be edited for this project where applicable.

1. Operations manuals for components and for systems as a whole include instructions for adjusting, operating, and extending the system.
2. Maintenance manuals for components and for system as a whole include repair procedures and spare parts documentation.
3. Point-to-point diagrams, cabling diagrams, construction details and cabling labeling details.
4. List of spare parts, materials and suppliers of components. Provide name, address and telephone number for each supplier.
5. Emergency instructions for operational and maintenance requirements.
6. Delivery time frame for replacement of component parts from suppliers.

7. Recommended inspection schedule and procedures for components and for system as a whole.
8. List of spare parts, materials and suppliers of components. Provide name, address and telephone number for each supplier.
9. Complete “reviewed” shop drawings and product data for components and system as a whole.
10. Troubleshooting procedures for each system and for each major system component.

D. Certified Record (PDF Format) of results for all cables/cable runs.

E. Data sheets showing all field labeling used for termination blocks, cable (outside plant, backbone, riser and horizontal) runs, and telecommunications outlets.

F. Cable Data:

1. Part number.
2. Reel or serial number, if available.
3. Fiber type.
4. Attenuation specifications.
5. Bandwidth specifications.

3.3 TRAINING

A. The Contractor shall be responsible for training of facility personnel. Training shall take place after occupancy and before acceptance and shall include programs for on-site operations and maintenance of technology and communications systems.

B. Training shall be for not more than ten (10) people, shall be held at the Owner's site and shall be of sufficient duration and depth to ensure that the trained personnel can operate the installed systems and can perform usual and customary maintenance actions.

C. Training to cover the location nomenclature, documentation structure contents, documentation maintenance procedures, a "walk-through" for location and labeling orientation, system reconfiguration using the COMMUNICATIONS EQUIPMENT ROOM (CER), COMMUNICATIONS CLOSET (CC) and COMMUNICATIONS PANEL (CP) facilities (termination hardware, punch blocks, etc.), operation of network equipment installed as part of the contract, test documentation, and troubleshooting of the signal cable portion of the installation.

D. The contractor shall record the training and provide (3) DVD copies of the training to the project manager.

3.4 WARRANTY

A. General:

1. All equipment is to be new and warranted free of faulty workmanship and damage.
2. Replacement of defective equipment and materials and repair of faulty workmanship within 24 hours of notification, except emergency conditions (system failures), which must be placed back in service within eight (8) hours of notification, all at no cost to the Owner.

3. The minimum warranty provisions specified shall not diminish the terms of individual equipment manufacturer's warranties.

B. Voice and Data Structured Cabling:

1. Contractor shall provide a written warranty from Commscope / Systimax that provides for the service and maintenance of premises wiring for 20 years from the Date of Project Completion.
2. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

C. Surge Suppression:

1. All surge suppression devices shall be warranted free from defects in material and workmanship for a period of five (5) years.
2. The manufacturer and installer at no cost to the Owner shall replace any suppressor, which shows evidence of failure or incorrect operation during the warranty period.
3. Equipment that is damaged by surges during the warranty period shall be replaced at no expense to the Owner.

D. Coaxial Cabling Infrastructure:

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed Coaxial Cabling Infrastructure. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

E. CATV Distribution System:

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed CATV Distribution System. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

F. Audio-Visual Systems:

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed Audio-Visual Systems. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

G. Overhead Paging System:

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed Overhead Paging/Intercom System. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

H. Network Equipment:

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed WAN and LAN Network equipment. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

I. Voice Equipment:

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed Voice equipment. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

J. Wireless Access System:

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed Wireless Access System. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

K. Emergency Phones / Call Boxes:

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed Emergency Phones / Call Boxes. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

L. Pathway and Support Infrastructure:

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed Pathway & Support Infrastructure. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

END OF SECTION 27 08 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 27 11 00
COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 01, 25, 26, 27 & 28 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Scope of Work:

1. The spaces required for technology systems support are defined in this document and the project drawings. They generally fall into specific areas as follows; Telecommunications Entrance Room (TSER), Equipment Room (ER), Main Distribution Frame (MDF), Intermediate Distribution Frame (IDF) or Horizontal Connection (HC) and Data Center MDA and HDA. In many cases the purpose of these room are combined to operate efficiently. All spaces work together to form the framework and infrastructure required for the complete and operational technology platform.

B. Section Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Telecommunications service entrance pathways.
5. Grounding.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel not exceeding 6 inches in width.

C. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

D. LAN: Local area network.

E. RCDD: Registered Communications Distribution Designer.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for

equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Interface details: Include rack/cabinet locations, wall mounted equipment, overhead cable tray, lighting fixtures, and power interface.
4. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

C. Qualification Data: For installer, qualified layout technician, installation supervisor, and field inspector.

D. Seismic Qualification Certificates: For floor-mounted cabinets, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

D. Grounding: Comply with ANSI-J-STD-607-A.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weather-tight, wait until work in spaces is complete and dry, and work above ceilings is complete.

1.7 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.

1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
2. Support brackets with cable tie slots for fastening cable ties to brackets.
3. Lacing bars, spools, J-hooks, D-rings and waterfalls.
4. Straps and other devices.

C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceways and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
2. Each equipment rack or cabinet will have two (2) dedicated 120 Volt, 20 amp circuits from the emergency power distribution system or UPS.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches installed 6” above finished floor, AFF. Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry" on all 4 walls of the technology spaces.

2.3 FIRESTOPPING

A. Sleeves:

1. Specified Technologies, Inc., EZ Path.

a. Series 22
b. Series 33
c. Series 44

2. Hilti, Speed Sleeve

a. CP 653/236323
b. CP 653/236324
c. CP 658/3409155
d. CP 658/3409157

B. Mechanical Firestop Appliances:

1. Dorn Equipment Corp, FirSto

a. FSP Series

2.4 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with ANSI-J-STD-607-A.

2.5 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and housing when so directed by service provider.

B. Install underground pathways complying with recommendations in TIA/EIA-569-A, "Entrance Facilities" Article.

C. Install underground entrance pathway complying with Division 26 Section "Raceways and Boxes for Electrical Systems."

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping". Comply with TIA/EIA-569-A, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A.

B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

C. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Labels shall be preprinted or computer-printed type.

END OF SECTION 27 11 00

SECTION 27 11 13
COMMUNICATIONS ENTRANCE PROTECTION

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Entrance Protection.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer’s specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Building Entrance Protector Terminal Manufacturer(s):

1. Circa
2. Porta Systems
3. Marconi

B. Approved Bonding Shield Connector Manufacturer(s):

1. 3M
2. Or Approved Equal

2.2 BUILDING ENTRANCE PROTECTOR TERMINALS

A. Indoor Building Entrance Protector Terminal:

1. The indoor building entrance protector terminal shall be equipped with 110-connector inputs and outputs and shall accommodate industry standard 5-pin protection modules.
2. The indoor building entrance protector terminal shall protect up to 100-pairs and shall be equipped with an internal fuse link.
3. The indoor building entrance protector terminal shall be wall or frame mountable, and able to be stacked for future expansion.
4. The indoor building entrance protector terminal shall be equipped with external ground connectors that accept 6-14 AWG ground wire.

B. Solid State Surge Protection Modules:

1. The solid-state surge protector module shall be 5-pin and shall provide transient and power fault protection for standard telephone line applications.
2. The solid-state surge protector module shall be designed to provide a balanced configuration to protect against line-to-line metallic surges.
3. The solid-state surge protector module shall feature an external failsafe mechanism, which permanently grounds module under sustained high current conditions.
4. The solid-state surge protector module shall feature nanosecond response time and safe mode operation in adverse situations.
5. The solid-state surge protector module shall be UL & UL Listed.

2.3 BONDING SHIELD CONNECTOR

A. Shield Connector:

1. The purpose of the bonding shield connector is to make a stable, low resistant electrical connection between the shield of a communications cable and a ground conductor.
2. The bonding shield connector shall be tin-plated tempered brass.

PART 3 - EXECUTION

3.1 BUILDING ENTRANCE PROTECTOR TERMINALS

A. All copper circuits shall be provided with protection between each building with an entrance cable protector panel. All building-to-building circuits shall be routed through this protector. The protector shall be connected with a #6 AWG copper bonding conductor between the protector ground lug and the telecommunications room (TR) busbar (TMBB).

B. Building entrance protector shall be installed in accordance with the recommendations contained in the ANSI/TIA-607-B Telecommunications Bonding and Ground Standard.

C. Building entrance protector panels shall be installed as per the requirements specified by the manufacturer's installation guidelines.

3.2 BONDING SHIELD CONNECTOR

A. Bonding shield connector shall be installed in accordance with the recommendations contained in the ANSI/TIA-607-B Standard.

B. Bonding shield connector shall be installed as per the requirements specified by the manufacturer's installation guidelines.

3.3 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION 27 11 13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 27 11 16
COMMUNICATIONS CABINETS, RACKS AND ENCLOSURES

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 26 – Electrical and Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Cabinets, Racks and Enclosures.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer’s specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Equipment Rack/Cabinet/Shelf Manufacturer(s):

1. Chatsworth
2. Middle Atlantic
3. Hubbell

2.2 EQUIPMENT RACKS/CABINETS/SHELVES

A. Equipment Racks:

1. The equipment rack shall be constructed of high strength steel.
2. The vertical rails of the equipment rack shall be equipped with the EIA hole pattern. Each rack will include 100 each combination pan head mounting screws.
3. Each equipment rack requires (2) 20 Amp circuits, provided by others.
4. Rack shall be: 48” H x 19" W x 30” deep and wall mounted.

5. Rack color shall be black
6. Racks shall include both horizontal cable management systems as shown on the drawings.

B. Equipment Cabinets: (see drawings for part numbers and additional requirements)

1. The frame of the equipment cabinet shall be constructed of high strength, lightweight aluminum or high strength steel.
2. Front and rear doors of the equipment cabinet shall be key lockable.
3. All cabinets on this project will be keyed alike unless otherwise noted.
4. The vertical 19” mounting rails of the equipment cabinet shall be equipped with the EIA hole pattern and will include 100 each mounting screws.
5. Each cabinet requires (2) 20 Amp circuits, provided by others.
6. The equipment cabinet shall be equipped with a fan unit.
7. Cabinet shall be: 48' H x 24" W x 30" D wall mounted.
8. Cabinet color shall be black, unless specified elsewhere.

PART 3 - EXECUTION

3.1 EQUIPMENT RACKS/CABINETS/SHELVES

A. Equipment racks shall be securely using minimum 3/8" hardware or as required by local codes.

B. Equipment cabinets shall be installed as per the requirements specified by the manufacturer's installation guidelines.

C. Equipment racks/cabinets shall be placed with a minimum of 36-inch clearance from the walls from the front as indicated on Drawings.

D. All equipment racks/cabinets shall be grounded to the telecomm ground bus bar.

E. Mounting screws not used for installing patch panels and other hardware shall be bagged and left with the rack upon completion of the installation.

3.2 BACKBOARDS

A. Backboards shall be fire-rated 3/4" void free plywood. Size of backboard shall be 4' x 8', mounted 6” AFF unless noted differently on Drawings. Backboards shall be painted with two (2) coats of light gray fire-retardant paint. Do not paint over label.

3.3 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Comm Systems for labeling details.

END OF SECTION 27 11 16

SECTION 27 11 19
COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Termination Blocks and Patch Panels.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer’s specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Patch Panel Manufacturer(s):

1. Systimax (Basis of Design, BOD)
2. Approved Alternative by County

B. Approved Optical Fiber Enclosure Manufacturer(s):

1. Systimax (BOD)
2. Approved Alternative by County

C. Approved Termination Block Manufacturer(s):

1. Systimax (BOD)
2. Approved Alternative by County

2.2 PATCH PANELS

A. Category 6 Patch Panel:

1. The Category 6 patch panel shall be compatible with 19" equipment racks, cabinets or wall mount brackets and provide for 48 ports unless otherwise noted on the drawings.
2. The Category 6 patch panel shall be equipped with 8-position modular ports and shall allow for termination using either T568A and T568B wiring schemes. All UTP cabling will be terminated 568B.
3. The Category 6 patch panel shall be equipped with front labeling space to facilitate port identification.
4. The connector module shall meet or exceed the Category 6 performance criteria per ANSI/TIA-568-C.2.
5. All patch panels will have 2 RU cable management panels above and below them. Install CMS covers when installation is complete.

2.3 OPTICAL FIBER PANELS/ENCLOSURES

A. Rack Mount Optical Fiber Panel/Enclosure:

1. The rack mount optical fiber panel/enclosure shall be equipped with either a swing out mechanism or a sliding drawer to access fibers.
2. The rack mount optical fiber panel/enclosure shall be capable of terminating tight-buffered or loose tube optical fiber cable.
3. The rack mount optical fiber panel/enclosure shall provide for bend radius control throughout the panel as well as storage space for slack cabling.
4. The panel/enclosure shall meet or exceed the performance criteria per ANSI/TIA-568-C.3.
5. The rack mount optical fiber panel/enclosure shall be equipped with optical fiber adapter panels.

    a. The optical fiber adapter panels shall accommodate either multimode or singlemode terminated optical fiber.
    b. The optical fiber adapter panels shall be compatible with ST, LC SC or APC connectors as indicated on the drawings.
    c. OM1 & OM2 multimode adaptors shall be beige in color and equipped with phosphor bronze sleeves.
    d. OM3 & OM4 laser optimized adaptors shall be aqua in color and equipped with zirconia ceramic sleeves.
    e. Singlemode adaptors shall be blue or green in color and equipped with zirconia ceramic sleeves.

2.4 TERMINATION BLOCKS

A. 110 Type Wiring Blocks/Cross-Connect Kits:

1. The 110-type wiring blocks shall be available in 100- and/or 300-pair configurations.
2. The 110-type wiring block shall be compatible with Category 6.
3. The cross-connect kits shall include all the components required to complete a wall-mounted 110 cross-connect installation and be available in both 100- and/or 300-pair configuration. (Includes 110-blocks, connecting blocks and designation strips).

4. The termination block shall meet or exceed the performance criteria per ANSI/TIA-568-C.2.
5. Backbone blocks shall use 5-pair connecting blocks on each 25-pair row.
6. Horizontal blocks shall use 4-pair connecting blocks on each 25-pair row.

PART 3 - EXECUTION

3.1 PATCH PANELS

A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer's recommendations and best industry practice.

B. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).

C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.

D. Cables shall be neatly bundled and dressed to their respective patch panel. Each patch panel shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

E. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.2 OPTICAL FIBER PANELS/ENCLOSURES

A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer's recommendations and best industry practices.

B. Each cable shall be individually attached to the respective splice enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.

C. Bend radius of the optic fiber cable in the panel/enclosure shall not exceed 10 times the outside diameter of the cable.

D. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.

E. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.

F. A maximum of 12 strands of fiber shall be spliced in each tray

G. All spare strands shall be installed into spare splice trays.

H. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.

3.3 TERMINATION BLOCKS

A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer's recommendations and best industry practice.

B. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).

C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.

D. Cables shall be neatly bundled and dressed to their respective termination block. Each termination block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

E. Each cable shall be clearly labeled on the cable jacket within 12" of the termination block at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

F. Wall mounted termination block fields shall be mounted on communications backboard and labeled using industry standard 25 pair labeling strips.

G. Wall mounted termination block fields shall be installed as per the requirements specified by the manufacturer's installation guidelines.

3.4 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION 27 11 19

SECTION 27 11 23
COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Cable Management and Ladder Rack.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer’s specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Horizontal Cable Management Manufacturer(s):

1. Panduit
2. Chatsworth
3. Belden
4. Systimax

B. Approved Vertical Cable Management Manufacturer(s):

1. Panduit
2. Belden
3. Chatsworth
4. Systimax

C. Approved Ladder Rack System Manufacturer(s):

1. Chatsworth Products, Inc.

2. B-Line
3. Hoffman

D. Approved Tie Wrap/Velcro Strap Manufacturer(s):

1. Thomas & Betts
2. Panduit

E. Approved C-Ring/D-ring Manufacturer(s):

1. Chatsworth Products, Inc.
2. Panduit

2.2 CABLE MANAGEMENT - HORIZONTAL

A. Horizontal Cable Management:

1. The horizontal wire manager shall be compatible with 19-inch equipment racks, cabinets or wall mount brackets.
2. The horizontal cable manager shall be double sided and provide support for patch cords at the front and horizontal cables at the rear of the panel.
3. The horizontal cable manager shall be 2 rack-units in height when matched with a 2 rack-unit patch panel or any switch.
4. The horizontal cable manager shall be 1 rack-unit in height when matched with a 1 rack-unit patch panel.

2.4 LADDER RACKS

A. Ladder Rack System:

1. See Drawings for ladder rack system details.
2. The ladder rack system shall be securely mounted to the walls and the overhead with hardware designed for use in ladder rack systems.
3. End caps shall be installed on the exposed ends of the ladder racks, channel supports and bolts. Protective covers shall be installed on threaded rods that come in contact with cabling plant.
4. Ladder Rack System color shall be black.

2.5 TIE WRAPS AND VELCRO STRAPS

A. Tie Wraps and Velcro Straps:

1. Backbone cables shall be fastened to support structures with Velcro straps.
2. Horizontal cables shall be fastened to support structures with Velcro straps.

    a. NO! plastic Tie Wraps shall be left on cables.
    b. Velcro Strap color shall be black.

2.6 DISTRIBUTION RINGS

A. Distribution Rings:

1. Distribution Rings shall be used on backboards to support cables, patch cords and cross-connect wire.
2. Distribution Rings shall be made of high-strength, fire-retardant material with rounded edges to prevent damage to cable and wire insulation.

PART 3 - EXECUTION

3.1 CABLE MANAGEMENT - HORIZONTAL

A. Horizontal cable managers shall be installed starting with one above and then proceeding with one below each patch panels in a 1:1 ratio (one horizontal cable manager per patch panel) or as indicated on Drawings.

3.2 LADDER RACKS

A. Ladder rack system shall be installed straight, level and perpendicular to walls and ceiling slabs.

B. Ladder racks shall be supported at 5' intervals maximum.

C. Provide all hardware, accessories, fasteners, anchors, threaded rods and support channels required to provide a complete ladder rack system.

D. See Drawings for ladder rack system details.

3.3 TIE WRAPS AND VELCRO STRAPS

A. Velcro straps shall be installed around cables at intervals of 12" minimum.

B. Velcro straps shall secure cables to ladder racks using an “X” pattern.

C. Do not over-cinch cables.

3.4 DISTRIBUTION RINGS

A. Distribution Rings shall be installed on backboard, straight and level.

3.5 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION 27 11 23

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 27 11 26
COMMUNICATIONS RACK MOUNTED POWER DISTRIBUTION

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Rack Mounted Power Distribution.

C. Product Specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer’s specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Power Distribution Unit Manufacturer(s):

1. Panduit
2. Geist
3. APC
4. Tripp-Lite

B. Approved Rack Mounted UPS Manufacturer(s):

1. APC
2. Liebert
3. Powerware
4. Tripp-Lite

2.2 POWER DISTRIBUTION UNITS

A. Power Distribution Unit, Rack mounted:

1. The power distribution unit shall be equipped with a minimum of twelve (12) 3-prong, 120 VAC outlets, 7' cord and shall not have an on/off switch.
2. The power distribution unit shall be equipped with surge protection with a 20 Amp current limit.
3. The power distribution unit shall be equipped with a bracket that enables it to be mounted vertically in cabinet on the left and right side without modification.

B. Power Distribution Unit, Cabinet mounted:

1. The power distribution unit shall be equipped with a minimum of eight (8) 3-prong, 120 VAC outlets, 7' cord and shall not have an on/off switch.
2. The power distribution unit shall be equipped with surge protection with a 20 Amp current limit.
3. The power distribution unit shall be equipped with a bracket that enables it to be mounted vertically in cabinet on the left and right side without modification.

PART 3 - EXECUTION

3.1 POWER DISTRIBUTION UNITS

A. Power distribution units shall be installed as per the requirements specified by the manufacturer's installation guidelines.

B. See Drawings for installation location on rack(s)/cabinet(s).

3.2 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION 27 11 26

SECTION 27 15 13
COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Copper Horizontal Cabling.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer’s specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. A single copper channel solution shall be installed for the entire project. Contractor shall install a Category 6 Plenum solution. The Contractor shall use a single manufacturer's copper or fiber solution (cables and components) for any given installation. The Contractor shall notify the Architect where a single product set solution is not possible.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Horizontal Copper Cable Manufacturer(s):

1. Systimax Basis of Design, (BOD)
2. Approved County Alternative

2.2 HORIZONTAL COPPER CABLE

A. 100 OHM Category 6 Balanced Twisted Pair UTP Cable:

1. The horizontal balanced twisted pair cable shall meet or exceed the Category 6 transmission characteristics per issue of ANSI/TIA/EIA-568-C.2.

2. Cable jacket shall be CMR or CMP rated (according to the space it occupies).
3. DATA cable jacket color shall be BLUE.

PART 3 - EXECUTION

3.1 HORIZONTAL CABLES

A. Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.

B. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.

C. Cable raceways shall not be filled greater than the ANSI/TIA/EIA-569-B maximum fill for the particular raceway type.

D. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.

E. Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.

F. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.

G. Horizontal cable runs shall not exceed 295’. Contractor shall immediately notify general Contractor, Project Manager and Architect of any cable runs that exceed this installed length.

H. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 to 60 inch (1.2 to 1.5 meter) intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.

I. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.

J. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

K. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the Contractor shall install appropriate carriers to support the cabling.

L. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.

M. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-C.2 document, manufacturer's recommendations and best industry practices.

N. All horizontal copper cables will be terminated as 568B per industry standards.

O. Leave a minimum of 12" of slack for twisted pair cables at the outlet. Cables shall be coiled in the in-wall box, surface-mount box or modular furniture raceway if adequate space is present to house the cable coil without exceeding the manufacturers bend radius. Excess slack, 10’ min, shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.

P. Cables shall be neatly bundled and dressed to their respective termination device. Each terminating device shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

Q. Each cable shall be clearly labeled on the cable jacket behind the termination device at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.2 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION 27 15 13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 27 15 43
COMMUNICATIONS FACEPLATES AND CONNECTORS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Faceplates and Connectors.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer’s specifications.

1.3 WORK INCLUDED

A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Copper Connectivity Manufacturer(s):

1. Systimax - Basis of Design (BOD)
2. County approved equal

B. Approved Faceplate Manufacturer(s):

1. Systimax (BOD)
2. County approved equal

2.2 COPPER CONNECTIVITY

A. Voice/Data Jacks:

1. Category 6, 8-Position, 8-Contact (8P8C) Modular Jack:

a. The connector module shall meet or exceed the Category 6 performance criteria per ANSI/TIA-568-C.2.
b. The eight-position connector module shall accommodate six-position modular plug modular cords without damage to either the cord or the module.
c. The connector module shall be designed for use at the work area (WA), communications room (TR) and/or equipment room (ER) without modification.
d. The connector module shall be available in both the T568A and T568B wiring configurations within the same module.
e. The connector module shall have an insulation displacement connection featuring insulation slicing of 22 to 24 AWG plastic-insulated solid copper conductors forming a gas-tight connection.
f. Icons shall be used if offered from the manufacturer.
g. Jack/Icon colors; County Data – Orange, Voice – White

2.3 FACEPLATES

A. Faceplates:

1. The faceplate housing the connector modules shall have no visible mounting screws.
2. It shall be possible to install the connector modules in wall-mounted single- and dual-gang electrical boxes, utility poles and modular furniture (cubicle) access points using manufacturer-supplied faceplates and/or adapters.
3. The faceplate housing the connector modules shall have the option of being mounted on adapter boxes for surface mount installation.
4. The faceplate housing the connector modules shall have a labeling capability using built-in labeling windows, to facilitate outlet identification and ease network management.
5. The faceplate housing the connector modules shall provide flexibility in configuring multimedia workstation outlets that respond to present or future network needs such as audio, data, video, coaxial and optical fiber applications.
6. Color shall be White.

PART 3 - EXECUTION

3.1 COPPER CONNECTIVITY

A. 8-position, 8-contact (8P8C) modular jacks shall be installed in accordance with manufacturer's recommendations and installation guides, and best industry practices.

B. All copper terminations for this project shall follow the EIA/TIA 568-B standard.

C. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).

3.2 FACEPLATES

A. Blank inserts shall be installed where ports are not used.

B. The same orientation and positioning of jacks and connectors shall be utilized through out the installation.

C. Faceplates shall be installed straight and level.

D. Faceplates shall be installed at the same heights as electrical faceplates.

E. The Contractor shall install blank outlet covers in any unused outlet of all faceplates.

F. Wall Phone Installations:

1. Furnish and install the wall phone faceplate according to the manufacturer's instructions. Each wall phone shall be terminated on its own dedicated 8P8C outlet where indicated on the drawings. No special panel shall be installed for wall phones.

3.3 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION 27 15 43

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 27 16 19
COMMUNICATIONS PATCH CORDS AND WORKSTATION CORDS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Patch Cords and Workstation Cords.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer’s specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Copper Patch Cord Manufacturer(s):

1. Systimax, Basis of Design (BOD)
2. County approved equal

B. Approved Fiber Patch Cord Manufacturer(s):

1. Systimax (BOD)
2. County approved equal

2.2 COPPER PATCH CORDS/WORKSTATION CORDS

A. Category 6 Patch Cords/Workstation Cords:

1. The Category 6 patch cord shall be 4-pair, with 24 AWG stranded copper conductors and 8-position modular plug.

2. The Category 6 modular cord cable shall be UL Listed as Type CMR.
3. The Category 6 patch cord shall meet or exceed the requirements of ANSI/TIA-568-C.2.
4. Provide the following numbers of patch cables:

a. 200, (7') Cat 6 patch cord color for data shall be: Blue

2.3 FIBER PATCH CORDS / WORKSTATION CORDS

A. Singlemode Fiber Patch Cords:

1. 8.3/125-micron singlemode fiber patch cord:

a. The 8.3/125-micron fiber used in the singlemode fiber patch cord shall have a maximum attenuation of 1.0dB/km@1310 nm and 1.0dB/km@1550 nm.
b. The optical fiber cord connector shall have a maximum insertion loss of 0.5 dB and a reflectance of -30 dB.
c. The 8.3/125-micron singlemode fiber patch cord/station cord shall meet or exceed the requirements of ANSI/TIA-568-C.3.
d. The optical fiber cord shall be Yellow and the connector shall be LC.
e. The singlemode fiber patch cord assembly shall be dual zip jacketed.

2. Provide the following numbers of patch cables:

a. 10 (4 feet) ST to ST fiber OS-2 SM patch cord; Yellow.
b. 10 (10 feet) ST to ST fiber OS-2 SM patch cord; Yellow.

PART 3 - EXECUTION

3.1 COPPER PATCH CORDS/WORKSTATION CORDS

A. Copper patch cords/workstation cords shall be installed as per the drawing requirements and as specified by the manufacturer's installation guidelines.

1. Workstation or end user patch cords shall be (7') long unless longer is required.

B. Coordinate the station and modular Work Area patch cords with the Furniture Contractors so as to not damage any equipment and leave the cords in a user-accessible location.

B. Install the Equipment Room patch cords with the Owner so as not to damage any equipment and leave the cords in a user-accessible location. Do not prohibit the installation of any rack-mounted equipment.

2.4 FIBER PATCH CORDS

A. Fiber patch cords/workstation cords shall be installed as per the drawing requirements and as specified by the manufacturer's installation guidelines.

2.5 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION 27 16 19

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 27 41 33
CATV VIDEO DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 01, 25, 26, 27 & 28 Specification Sections, apply to this Section.

1.2 SUBMITTALS

A. Provide product data from manufacturer's specifications.

1.3 WORK INCLUDED

A. Provide equipment, labor and materials necessary to furnish and install a complete, operational Cable Distribution System for CATV television service. All equipment shall be UL listed and approved and shall comply with NFPA standards. System shall be complete and ready for connection to head-end equipment and color television receivers at each location. The service provider will provide Head-end equipment for contractor to connect to and the owner shall furnish television receivers.

B. Provide a minimum of one, rack mounted 8-Port distribution hubs in each Equipment Room, and distribution closet within the building.

C. The video distribution system shall provide for distribution of live and recorded video. The contractor shall provide and install a complete analog and digital video distribution system, which includes all equipment as required for a complete and functional system as shown on the drawings.

1.4 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions apply to work of this Section.

B. This Section is a Division 27 section and is part of each Division 27 Section making reference to the television system specified herein.

1.5 REFERENCES

The contractor will provide all materials, equipment and installation in compliance with the latest applicable standards. These standards shall include but are not limited to the following:

A. American National Standards Institute (ANSI)

1. ANSI T1.404 (DS3) and CATV Applications

B. American Society for Testing and Materials (ASTM)

C. Electronics Industry Alliance (EIA)

D. Federal Communications Commission (FCC)

1. FCC Part 15, Radiated Emissions Limits, revised 1998
2. FCC Part 76, Cable Television Service, revised 1998

E. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

1. IEEE Standard 81-1983, IEEE Guide for Measuring Earth Resistance, Ground Impedance, and Earth Surface Potential of a Ground System
2. IEEE 802.4 Broadband Applications
3. IEEE 802.7 Broadband Specifications Standard
4. IEEE Standard 1100-1999, Recommended for practice for Powering and Grounding Sensitive
5. Electronic Equipment in Industrial and Commercial Power Systems (IEEE Emerald Book)

F. International Organization for Standardization (ISO)

G. National Cable Television Association (NCTA)

1. NCTA-02 NCTA Recommended Practices for Measurements on Cable Television Systems.

H. National Association of Broadcasters Engineering Handbook

I. National Electrical Code (NEC)

1. Article 250, Grounding.
2. Article 300, Part A. Wiring Method.
3. Article 310, Conductors for General Wiring.
4. Article 800, Communications Systems.

J. National Electrical Manufacturers Association (NEMA)

K. National Fire Protection Association (NFPA)

1. NFPA-70, National Electrical Code
2. NFPA-75, Protection of Electronic Computer Data Processing Equipment.
3. NFPA-101, Life Safety Code
4. NFPA-297, Guide on Principles and Practices for Telecommunications Systems
5. NFPA-780, Standard for the Installation of Lightening Protection Systems.

L. National Institute Standards and Technology (NIST)

M. Uniform Building Code (UBC)

N. Underwriters Laboratories, Inc. (UL)

1. In the event of any conflicts between documents referenced herein and the contents of this specification, the Contractor shall notify in writing to General Contractor of any such occurrences before the purchasing of any equipment, materials and/or installation by the Contractor. Project manager will notify the

Contractor of any actions required to resolve these conflicts. Such actions may include but are not limited to: design changes, equipment, materials and/or installation changes. In any event Contractor shall not supersede specifications and standards from the latest NFPA and NEC publications.

PART 2 - PRODUCTS

2.1 ANALOG VIDEO HEAD END

A. Provided by local service provider. (Existing)

2.2 ANALOG VIDEO DISTRIBUTION VIA UNSHIELDED TWISTED PAIR

A. From each main distribution room or intermediate distribution closet, the analog video signal will be distributed to analog video outlets and wall plates via Unshielded Twisted Pair cable. This distribution will utilize rack-mounted balun patch panels in the equipment rooms and a balun integrated into each analog video outlet or wall plate. The rack-mounted balun patch panel will convert the RF broadband signal from the fiber optic receiver to support transmission to UTP, and interconnect the UTP using RJ-45 connectors. The balun integrated into each analog video outlet will convert the RF signal from UTP to coaxial cable using an F-connector.

B. Approved equipment manufacturer is:

1. Lynx Broadband Basis of Design (BOD)
2. Or approved equal to provide broadcast quality video signal delivery to each video outlet.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all equipment in accordance with manufacturer’s published instructions. Installation must be performed by a manufacturer’s Certified Dealer to assure proper installation and accountability.

B. It is the CATV contractor's responsibility to coordinate with the structured cabling contractor for the proper installation and termination required for the associated Category 6 data outlet at each faceplate.

C. The system shall be installed to the following performance levels:

1. Frequency response of the system shall pass 5 MHz to 860 MHz.
2. Amplitude response for this spectrum will be +/- 5 dB with respect to the line represented by normal cable tilt.
3. Signal level at each outlet at 860 MHz will be 10 dB +/- 5 dB.
4. Tilt should not exceed 7 dB on the visual carrier.
5. Maximum loss from the head-end to any TV set shall not exceed 45 dB at 550 MHz and not exceed 40 dB at channel 2 visual carrier.
6. Room to room isolation shall be greater than 28dB.

7. Visual carrier to noise ratio on any channel (6MHz bandwidth) shall be at least 45 dB at any TV set.
8. Signal/cable, ghosts and shadows caused by the system shall be more than 40 dB below the respective picture carrier.

3.2 FIELD QUALITY CONTROL

A. Quality Control: Field-testing and inspection.

B. Testing and Inspection:

1. Perform tests and provide test equipment, tools, and personnel required to conduct system tests and inspections.
2. Provide an actual demonstration of system function.
3. An acceptance test period of thirty days shall begin at the start of the acceptance test. Any system failure during the acceptance test period will suspend the acceptance test. The thirty-day test period will restart when the required repairs have been made and certified.
4. Perform all tests in the presence of owners' representative. The Owner reserves the right to accept any portion or activate any phase prior to acceptance of entire system.
5. The test report shall contain the description of all tests performed, the results obtained, and any required adjustments or modifications necessary as a result of testing and installation. Contractor shall coordinate content of test report with owner before execution. The test report shall be signed by an authorized representative of the Contractor. At least three copies of the test report shall be sent to project engineer to review.
6. Testing and test equipment will be provided by the contractor to test and to certify 100% operational condition of all materials and equipment.

C. Service Contract:

1. This contractor shall be prepared to offer a service contract for the maintenance of the system after the guarantee period.
2. Contractor shall produce evidence that he has had a fully-experienced and established service organization for at least five (5) years and proven satisfactory installations during that time.

END OF SECTION 27 41 33

SECTION 27 51 00
FIRE STATION ALERTING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation of the fire-station alerting systems (FSA) as required for the complete performance of the work, and as shown on the Drawings and as herein specified.

B. Section Includes: The work specified in this Section includes, but shall not be limited to, the following:

1. Provide turnkey FSA system including all equipment, devices, cables, connections, connectors, software, programming, installation, system configuration, startup, testing, training necessary for the complete installation and final acceptance.

1.2 SUBMITTALS

A. Product Data: Submit product data cutsheets for proposed materials. Submit sufficient information to determine compliance with the Drawings and Specifications. Clearly indicate all variations and options proposed for installation.

B. Comply with Division 27 00 00.

C. Configuration: Submit FSA equipment and cabling configuration information, including the physical locations and connections of all active and conductive components.

D. Shop Drawings: Submit scaled shop drawings depicting the intended installation location for RF antenna, receiver equipment, audio equipment, loudspeakers, light notification devices, digital message display units, etc., relevant clearance requirements, and all other equipment and devices intended for installation and completion of the system. Indicate all relevant dimensions, and document that installation is feasible as proposed. Provide necessary cabling specification including circuit and load calculations.

1.3 OPERATION AND MAINTENANCE

A. Operation and Maintenance Data: Prior to substantial completion, submit operation and maintenance data for cables, equipment, devices, software, and other components of the FSA system. Submit as indicated in section 27 00 00.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. The system manufacturer must:

a. Have a minimum of five years' experience in producing the products and type of system included in this specification section.
b. Produce a system that satisfies all specified features, functions, and product requirements.
c. Guarantee the availability of the replacement parts for the designed system for a minimum of seven years from the date of final acceptance of the system by the Contracting Officer.

B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.

C. Without limiting the generality of other requirements of this Section, all work specified herein shall conform to or exceed the applicable requirements of the standards listed in Specification Section 270501 Communications Codes and Standards. Wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

D. Pre-Installation Conference: Prior to commencing the installation, meet at the Project site to review the material selections, installation procedures, and coordination with other trades. Pre-installation conference shall include, but shall not be limited to, the Contractor, the Installer, manufacturer's representatives, and any trade that requires coordination with the work. Date and time of the pre-installation conference shall be acceptable to the Owner and the Architect.

E. Approved Components: Obtain equipment, stations, devices, accessories, and cabling to form a single system made solely of components approved by FSA system manufacturer. Any materials which are not produced by the system manufacturer(s) shall be acceptable to and approved by the manufacturer.

F. Provide equipment and devices complying with applicable UL standards, UL-1418, 1419, 813, 60065 for respective components.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.

B. Store materials in their original, undamaged packages and containers, inside a well ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.6 CONTRACTOR WARRANTY

A. Special Warranty: Submit a written warranty executed by the manufacturer, the Installer, and the Contractor, agreeing to repair or replace FSA system components and cabling that fail in materials or workmanship within the specified warranty period.

1. Warranty Period: Warranty period shall be two years from the date of substantial completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. All products shall comply with applicable codes and standards. Refer to Specification Section 270501 Communications Codes and Standards for a list of particularly relevant codes and standards.

B. Systems/Manufacturers:

1. Motorola

C. The FSA system must:

1. Function as separate dedicated system for Fire-Station Alerting.
2. Be compatible with Hernando County Type 4 E911 Public Safety Answering Point Transmission and Dispatch at owner provided FCC licensed radio bands.
3. Receive the above signal via RF antenna and 50 Ohm cable. Be compatible with VoIP input and output for future modification.
4. Be compatible with Computer Aided Dispatch System.
5. Amplify the signal to desired loudspeaker levels.
6. Distributed the signal through speakers.
7. Be capable of tone adjustment.
8. Be capable of multizone distribution of signal.
9. Be scalable and compatible with equipment readily available in the market.
10. Distribute the notification signal through light speaker for visual notification of staff.
11. Be capable of converting the received signal to digital text-message display units.
12. Incorporate response time counter and display.
13. Be manually resettable.
14. Be interfaceable with local computer for data printout and call and response tracking through software.
15. Be capable of Web interface.
16. Store data in local memory.

2.2 HEAD END EQUIPMENT

A. Head-end equipment shall consist of the following:

1. Existing RF antenna shall be relocated as shown on the plans and mounted to relocated lattice triangle pole to match existing configuration.
2. Master Control Unit consisting of:

a. RF Tuner:

i. AM/FM input ready (Verify frequency with owner)
ii. 50/75-Ohm antenna connection
iii. 120V/60Hz power input
iv. RC Jack mono and stereo output
v. Manual Volume Control
vi. Digital alphanumeric readout/display
vii. Self contained or shelf mount.

b. Amplifier:

i. Supporting 70V speakers
ii. 120/60Hz power supply
iii. 60W speaker output minimum.
iv. Auxiliary output supporting light and message notification
v. Zone Speaker and Auxiliary outputs
vi. Tonal adjustment of outputs
vii. Lan connection for print-outs and remote computer interface
viii. Locally Configurable
ix. Wall, desktop, or rack mount

c. Basis of Design: Purvis Systems, Station Control Unit with Audio Relay Expansion Module.

2.3 DEVICES

A. Illuminated speaker: 8” Cone, 1W, 70V, with LED soft start ramped night lighting at time of dispatch. Basis of Design: Purvis System.

B. Strobe Light/Color Indicator: LED lighting notification device for color coded alerting, 48VDC, Form C contact input PoE from controller, 5W. Basis of Design: Purvis Systems.

C. Message Sign: Digital LED single-line alerting message display. Provide three lines of message: one for dispatch information, one for turnout timer, and one for unit status. Basis of Design: Purvis Systems.

D. Loudspeakers: Wet listed, Weatherproof, 7.5W, 70V, variable tap impedance, horn type loudspeaker. Basis of Design: Purvis Systems.

E. Turnout Timer: Led Display, counting upwards, provided with optical presence detector for each timer. Basis of Design: Purvis Systems.

F. Flat Panel Message Board/Monitor: Flat Panel TV displaying incident information. Basis of Design: Purvis System.

G. Multicolored Tower/Board: LED Light Bar with 5 individual color displaying segments programmed for incident types: white, red, blue, green yellow. Basis of Design: Purvis Systems.

2.4 SOFTWARE

A. Web or desktop based system providing system configuration interface, viewing of system status, peripherals device status, keeping the log of events, and tracking monthly activities, capable of printer interface.

2.5 CABLES

A. RF Antenna cable shall be 50-Ohm type, RG-11, RG-59, or RF600, wet location listed, rated for 80ºC outdoor installation, shielded, copper core.

B. Data and PoE cables: Cat5e type, 4-pair, 24AWG, jacketed.

C. 70V Power Cables: #14 AWG Cu., 2-pair, listed for speakers.

PART 3 - EXECUTION

3.1 PROJECT MANAGEMENT

A. Assign a single project manager to this project who will serve as the point of contact for the Owner and the Construction team.

3.2 COORDINATION WITH OTHER TRADES

A. Coordinate all work with other subcontractors and trades and verify pre-existing conditions.

B. All raceways for FSA system wires and devices shall be installed by electrical contractor. Coordinate requirements with the electrical contractor during construction.

C. Immediately notify the Owner, GC and Consultant(s) in writing of any discrepancies.

3.3 INSTALLATION

A. Execute work in accordance with Codes and Standards.

B. Install work neatly, plumb and square and in a manner consistent with standard industry practice.

C. All ceiling devices shall be centered on ceiling tiles.

D. Avoid conflicts with existing mechanical devices, electrical boxes, plumbing systems, when installing components in and above acoustical ceiling.

E. Throughout the construction, protect work from dust, paint and moisture as dictated by site conditions. Contractor will be fully responsible for protection of his work during the construction phase up until final acceptance by the Owner.

F. Install equipment according to manufacturer's recommendations. Provide any necessary installation accessories, such as hardware, adaptors, brackets, rack mount.

kits or other accessories recommended by the manufacturer for proper assembly and installation.

G. Secure equipment and devices firmly in place, including speakers, equipment racks, system cables, etc.

H. Do not impose the weight of equipment or fixtures on supports provided for other trades or systems.

I. FSA Contractor is responsible for means and methods in the design, fabrication, installation and certification of any supports, mounts, fasteners and attachments for the equipment.

J. Electrical contractor is responsible for means and methods in the design, fabrication, installation and certification of any supports, mounts, fasteners and attachments for the raceways.

K. Finishes for any exposed work such as plates, racks, panels, speakers, etc. shall be approved by the Owner.

L. Coordinate cover plates with field conditions. Size and install cover plates as necessary to cover both joints between back boxes and surrounding wall.

M. Color code all FSA distribution wiring to a unique set of colors. At a minimum, all equipment, cable duct and/or conduit, enclosures, wiring, terminals, and cables shall be clearly and permanently labeled according to and using the provided record (shop) drawings, to facilitate installation and maintenance.

N. Primary system input AC power shall be provided by the electrical contractor in accordance with the drawings and division 26 specifications.

O. Delivery: Deliver materials to the job site in OEM's original unopened containers, clearly labeled with the OEM's name and equipment catalog numbers, model and serial identification numbers. The RE may inventory the cable, patch panels, and related equipment.

P. Storage and Handling: Store and protect equipment in a manner, which will preclude damage.

Q. Equipment Racks/Cabinets:

1. FILL unused equipment mounting spaces with blank panels or vent panels. Match color to equipment racks/cabinets.
2. Provide security covers for all devices not requiring routine operator control.

R. Electrical contractor shall provide continuous raceway/conduit with no more than 40% fill.

S. Ensure a minimum of 36 inches access around each cabinet and/or rack to comply with OSHA Safety Standards. Cabinets and/or Racks installed side by side – the 36” rule applies to around the entire assembly.

T. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems”.

U. Where raceway is to be EMT (conduit), wiring of differing classifications shall be run in separate conduit.

V. Where raceway is to be an enclosure (rack, tray, wire trough, utility box) wiring of differing classifications which share the same enclosure shall be mechanically partitioned and separated by at least four (4) inches. Where Wiring of differing classifications must cross, they shall cross perpendicular to one another.

W. Use grommets around cut-outs and knock-outs where conduit or chase nipples are not installed.

X. Wire nuts, electrical tape or “Scotch Lock” connections are not acceptable for FSA system installation. Use terminal blocks if splicing is necessary. If specified terminal blocks are not designed for rack mounting, utilize ¾” plywood or 1/8” thick aluminum plates/blank panels as a mounting surface. Do not mount on the bottom of the rack.

Y. Employ permanent strain relief for any cable with an outside diameter of 1” or greater.

Z. For crimp-type connections, use only tools that are specified by the manufacturer for the application.

AA. Free run cables shall be hidden, protected, fastened and tied at 24 in. intervals, maximum, to building structure. Exception is fished cables through existing framed walls.

BB. Test all cables per Div 27 Specification standards after installation and replace any defective cables.

CC. For free run cables, means of cable support are cable trays and J-hooks. Velcro wrap cable bundles loosely to the means of support with plenum rated Velcro straps. Plastic tie wraps are not acceptable as a means to bundle cables.

DD. Run cables parallel to walls.

EE. Do not lay cables on top of light fixtures, ceiling tiles, mechanical equipment, or ductwork. Maintain at least 2’-0” clearance from all shielded electrical apparatus.

FF. Ends of cables shall be properly terminated on both ends per industry and OEM’s recommendations.

GG. Terminate all conductors. No cable shall contain unterminated elements. Make terminations only at outlets and terminals.

HH. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

II. Cable and Wires shall be labeled at both ends in accordance with ANSI/EIA/TIA-606A. Labels shall be permanent in contrasting colors. Cables shall be identified according to the System, Zone and Circuit shown on “Shop Drawings.”

JJ. System equipment shall be permanently labeled with contrasting plastic laminate or Bakelite material. System equipment shall be labeled on the face of the unit corresponding to its source.

KK. Conduits shall be provided in accordance with Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and NEC Articles 517 for Critical Care and 800 for Communications systems, at a minimum.

LL. All penetrations from ground level to first level, including inner annular space of conduits shall be sealed watertight.

MM. All conduits run in first floor ceiling shall be attached to undersized of deck.

3.4 CUTTING, CLEANING, AND PATCHING

A. The contractor shall keep their work area clear of debris and clean the construction and work area daily at completion of work.

B. Contractor shall patch and paint any wall or surface that has been disturbed by the execution of this work. Methods to be agreed upon with the Owner.

C. The Contractor shall be responsible for providing any additional cutting, drilling, fitting or patching required that is not indicated in Drawings to complete the Work or to make its parts fit together properly.

D. If core drilling of existing (previously installed) concrete is required, the location of such drilling shall be clearly identified in the field and the location shall be approved by the Owner and Owner's engineer prior to commencement of coring work.

3.5 FIREPROOFING

A. Where FSA system cables, wires or conduits penetrate fire-rated UL assemblies, walls, floors or ceilings, fireproof the opening with UL listed fire-stops or sealants as required to maintain the rating of the assembly.

B. Provide conduit sleeves for cables that penetrate fire rated walls and Telecommunications Rooms floors and ceilings. After the cabling installation is complete, install fire-stop materials or sealant in and around all conduit sleeves and openings. Use UL listed fire-stops and sealants to maintain the fire rating of the assemblies.

3.6 GROUNDING

A. Ground all metallic components of the FSA system including equipment and devices to eliminate shock hazard and to minimize ground loops, common mode returns, noise pickup, cross talk, and other impairments.

B. Provide separate #6 bare copper grounding to local grounding bas bar for all headend equipment. Bond all shielded conductors to grounding electrode system.

D. Bond the relocated Antenna pole to the grounding electrode system using #6 AWG Cu. Comply with OSHA and the NEC NFPA 70 in installation of grounding system components.

3.7 SYSTEM TESTING

A. In addition to AHJ inspections, all inspections and tests shall be conducted by an OEM-certified contractor representative and witnessed by the Owner or Owner's representative.

B. The results of the inspection will be recorded in a checklist report format and turned over to the Owner.

C. Upon completing installation of the FSA System, the Contractor shall set, balance, and completely pretest the entire system under full operating conditions.

D. During the System Pretest the Contractor shall verify (utilizing approved test equipment) that the System is fully operational and meets all the System performance requirements of the standards.

E. The Contractor shall pretest and verify that all FSA functions and specification requirements are met and operational and that no unwanted signal distortion, noise pulses, glitches, feedbacks, audio hum, poling noise, etc. are present.

At a minimum, each of the following locations shall be fully pretested:

1. Interface of the headend equipment and antenna, and the antenna and the Seminole County E911 Dispatch System.
2. Software functions.
3. Interface of the headend equipment with distribution devices.
4. Operation of devices.
5. Sound levels and tonality.
6. Light patterns and levels.
7. Software performance in configuring and tracking the system.
8. Network interfaces such as LAN and printers.
9. Zoned response of the system.
10. Interface with door ringer and other peripheral devices
11. Power source status and Battery capacity and status.
12. System trouble and failure reporting.

C. The Contractor shall provide four (4) copies of the recorded system pretest measurements and the written certification that the System is ready for the formal acceptance test shall be submitted to the Owner.

D. Acceptance Test:

1. Final acceptance test shall be performed after the pretest and with 10 working days written notice prior to the date the acceptance test is expected to begin. The System shall be tested in the presence of the Owner or Owner's representative.
2. Physical and Mechanical Inspection: all sub-systems are completely and properly installed to ensure they are operationally ready for proof of performance testing. Each device and equipment shall be checked for proper labeling. The distribution system shall be checked at each interface, junction, and distribution point.
3. Operational Test: Control equipment and devices shall be checked to verify that each meets all performance requirements. Operation shall be free of distortions such as intermodulation, data noise, popping sounds, erratic system functions, glitches, errors, defects, etc.
4. At the conclusion of the Acceptance Test, using the generated punch list (or discrepancy list) the Owner and the Contractor shall jointly agree to the results of the test, and reschedule testing on deficiencies. Any retesting to comply with these specifications will be done at the Contractor's expense.
5. Acceptable Test Equipment: Any industry acceptable equipment with proof of calibration.

3.8 TRAINING

A. Provide operations training to Owner-selected staff and the administrator who will be assigned to work with new FSA system.

B. Provide maintenance and troubleshooting training Owner's administrator and IT staff.

C. Hours of required training and method of training delivery to be separately agreed on with the owner.

END OF SECTION 27 51 00

THIS PAGE INTENTIONALLY LEFT BLANK

Division 28

Electronic Safety and Security

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 28 00 00
ELECTRONIC SAFETY AND SECURITY SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable requirements of General Requirements/Provisions shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the general requirements relating to Electronic Safety and Security Systems.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

D. Related Specifications:

1. Division 00
2. Division 01
    a. Section “Project Management and Coordination”
    b. Section “Submittal Procedures”
    c. Section “Product Requirements”
    d. Section “Closeout Procedures”
    e. Section “Warranties”
3. Division 07 Section "Firestopping"
4. Division 08 Section "Access Doors and Frames."
5. Division 09 Section "Interior Painting"
6. Division 26
    a. Section “Grounding and Bonding for Electrical Systems”
    b. Section “Raceways and Boxes for Electrical Systems”
    c. Section “Surge Protection Devices”
7. Division 27 all applicable Sections
8. Division 28 all Sections

E. Applicable requirements of the Division 26, 27 and 28 Design Criteria shall all be considered a part of this Division and shall have the same force as if written herein full.

1.2 QUALITY ASSURANCE

A. Specifications, Standards and Codes: All work shall be in accordance with the following:

1. 2010 Florida Building Code (FBC) with 2012 supplement
2. Standard Requirements for Educational Facilities (SREF)
3. The 2008 edition of the National Electrical Code (NFPA 70)
4. American National Standards Institute (ANSI)
5. National Electrical Manufacturers Association (NEMA)

6. Telecommunications Industries Association (TIA)
7. Electronic Industries Association (EIA)
8. Institute of Electrical & Electronics Engineers (IEEE)
9. Underwriters Laboratories (UL)

    a. U.L. 13 - Power-Limited Circuit Cables
    b. U.L. 444 - Communications Cables
    c. U.L. 497 - Protectors for Paired Conductor Communication Circuits
    d. U.L. 497A - Secondary Protectors for Communication Circuits
    e. U.L. 497B - Protectors for Data Communication and Fire Alarm Circuits
    f. U.L. 910 - Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air
    g. U.L. 1449 - Transient Voltage Surge Suppressors
    h. U.L. 1581 - Reference Standard for Electrical Wires, Cables AND Flexible Cords.
    i. U.L. 1666 - Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
    j. U.L. 1685 - Vertical-Tray Fire Propagation and Smoke Release Test for Electrical and Optical-Fiber Cables
    k. U.L. 1778 - Uninterruptible Power Supply Equipment

10. American Standards Association (ASA)
11. Building Industry Consulting Services International (BICSI)
12. Federal Communications Commission (FCC)
13. Occupational Safety and Health Administration (OSHA)
14. American Society of Testing Material (ASTM)
15. Americans with Disabilities Act (ADA)
16. Local city and county ordinances governing electrical work
17. The County Voice, Video Data Infrastructure Guidelines
18. In the event of conflicts, the more stringent provisions shall apply.

1.3 SUMMARY

A. The work to be done under this division of the Specifications shall include the furnishing of labor, material, equipment and tools required for the complete installation of the work indicated on the Drawings or as specified herein.

B. All materials, obviously a part of the Security Infrastructure and necessary to its proper operation, but not specifically mentioned or shown on the Drawings, shall be furnished and installed without additional charge.

C. The Drawings and Specifications are complementary to each other and what is called for by one shall be as binding as if called for by both. If a discrepancy exists between the Drawing and Specifications, the higher cost shall be included, and the engineer shall be notified of the discrepancy.

1.4 WORK INCLUDED

A. The Electronic Safety and Security Infrastructure installed and work performed under this Division of the Specifications shall include but not necessarily be limited to the following:

1. Security systems cabling infrastructure.

2. Security systems conduits, raceways, cable tray, racks, cabinets, panels and equipment mounting boards.
3. Grounding and Bonding of Electronic Safety and Security Equipment.
4. Electronic Safety and Security Life Safety Plan for construction site specific.

1.5 DEFINITIONS

A. Terms: The following definitions of terms supplement those of the General Requirements and are applicable to Division 28 – Electronic Safety and Security.

B. Provide: As used herein shall mean “furnish, install and test (if applicable) complete.”

C. Infrastructure: As used herein shall mean cable, conduit, raceway, cable tray or j-hooks with all required boxes, fittings, connectors, and accessories; completely installed.

D. Work: As used herein shall be understood to mean the materials completely installed, tested and certified including the labor involved.

E. Main Distribution Frame (MDF): The primary communications room for a facility used to house head-end equipment for various systems and interconnect with equipment in other communications rooms and spaces via backbone cables.

F. Intermediate Distribution Frame (IDF): Secondary communications rooms located throughout a facility and used to extend horizontal cables to system devices.

1.6 DRAWINGS

A. Drawings are generally diagrammatic and show the arrangement and location of pathways, outlets, support structures and equipment. The Contractor shall carefully investigate the structural and finish conditions affecting his work and arrange his work accordingly. Should conditions on the job make it necessary to make adjustments to pathways or materials, the Contractor shall so advise the Engineer and secure approval before proceeding with such work.

B. Where exact locations are required by equipment for stubbing-up and terminating conduit concealed in floor slabs, the Contractor shall request shop drawings, equipment location drawings, foundation drawings, and any other data required by him to locate the concealed conduit before the floor slab is poured.

C. Materials, equipment or labor not indicated but which can be reasonably inferred to be necessary for a complete installation shall be provided. Drawings and Specifications do not undertake to indicate every item of material, equipment, or labor required to produce a complete and properly operating installation.

D. The right is reserved to make reasonable changes in locations of equipment indicated on Drawings prior to rough-in without increase in contract cost.

E. The Contractor shall not reduce the size or number of conduit runs indicated on the Drawings without the written approval of the Engineer.

F. Any work installed contrary to Contract Drawings shall be subject to change as directed by the Engineer, and no extra compensation will be allowed for making these changes.

G. The location of equipment, support structures, outlets, and similar devices shown on the Drawings are approximate only. Do not scale Drawings. Obtain layout dimensions for equipment from Architectural plans unless indicated on Communications plans.

H. Schematic diagrams shown on the Drawings indicate the required functions only. The technology of a particular manufacturer may be used to accomplish the functions indicated without exact adherence to the schematic Drawings shown. Additional labor and materials required for such deviations shall be furnished at the Contractor's expense.

I. Verify the ceiling type, ceiling suspension systems, and clearance above hung ceilings prior to ordering cabling and associated hardware. Notify the Engineer of any discrepancies.

J. Review all drawings for modular furniture, power poles and other conditions that may require additional coordination by the contractor.

K. Portions of these Drawings and Specifications are abbreviated and may include incomplete sentences. Omissions of words or phrases such as “the Contractor shall,” “shall be,” “as indicated on the Drawings,” “In accordance with,” “a,” “the” and “all are intended” shall be supplied by inference.

1.7 SUBMITTALS

A. Required to be submitted prior to the commencement of work:

1. Contractor qualifications information including but not limited to:

   a. Name, qualifications, etc. of company providing and installing system
   b. Submit copy of Florida Registered Firm certificate
   c. Submit copy of Florida Contractor's license
   d. Contractor certification by manufacturers
   e. Narrative of System Operation
   f. Detailed step-by-step testing procedure for a functional checkout and test

B. Submit for approval, details of all materials, equipment and systems to be furnished. Work shall not proceed without the Owner and/or the Project Manager's approval of the submitted items. Four (4) copies of the following shall be submitted:

1. Submittals for individual systems and equipment assemblies that consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered, reviewed or stored, and such submittals will not be returned except at the request and expense of the Contractor.
2. Shop drawings shall include equipment racks, patch panels, termination blocks, connection details, rack mounting details and any other details not included in the construction drawings.

C. Any materials and equipment listed that are not in accordance with Specification requirements may be rejected.

D. The approval of material, equipment, systems and shop drawings is a general approval subject to the Drawings, Specifications and verification of all measurements at the job. Approval does not relieve the Contractor from the responsibility of shop drawing errors. The Contractor shall carefully check and correct all shop drawings prior to submission for approval.

1.8 QUALITY ASSURANCE

A. Equipment and materials required for installation under these Specifications shall be the current model and new (less than one [1] year from the date of manufacture), unused and without blemish or defect.

B. Equipment shall bear labels attesting to Underwriters Laboratories, where subject to label service. Manufacturers of equipment and materials pertinent to these items shall have been engaged in the manufacture of said equipment a minimum of ten (10) years and, if so directed by the Owner, be able to furnish proof of their ability by submitting affidavits and descriptive data about their product including size and magnitude comparable to requirements specified herein.

1.9 CONTRACTOR QUALIFICATIONS

A. The Contractor shall have total responsibility for the coordination and installation of the work shown and described in the Drawings and Specifications. The Contractor shall be a company specializing in the design, fabrication and installation of integrated Security systems.

B. Security Systems specified shall be installed under the direction of a qualified System Manufacturer Certified Contractor. Qualification requirements shall include submittal by the Contractor to the Architect of the following:

1. List of previous projects of this scope, size and nature; including names and sizes of projects, description of work, time of completion and names of contact persons for reference.
2. Shall certify that they are manufacturer-authorized for work to be performed.

C. The Contractor shall maintain an office within fifty (50) miles of the project site with the capability to provide emergency response.

D. The Installer shall be a direct sales division of, or an authorized and designated dealer for the equipment manufacturer whose product he intends to install.

E. The Installer shall be currently licensed by the Electrical Contractor’s Licensing Board with the appropriate license for the system he intends to install.

F. Sub-Installers (i.e. Installers two levels beneath the Electrical Sub-Contractor) shall not be allowed.

1.10 COORDINATION WITH OTHER TRADES

A. The Contractor shall coordinate the Security systems work with that of other sections as required ensuring that the entire Electronic Safety and Security work will be carried out in an orderly, complete and coordinated fashion.

1.11 PERMITS

A. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Owner all certificates of said inspection issued by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Where equipment is identified by manufacturer and catalog number, it shall be as the base of requirements for quality and performance. Where manufacturers for equipment are identified by name, the Contractor may submit for approval, similar equipment of other manufacturers as substitution. The Engineer's decision as to whether the submitted equipment is acceptable shall be final and binding.

B. All changes necessary to accommodate the substituted equipment shall be made at the Contractor's expense, and shall be as approved by the Engineer. Detailed drawings indicating the required changes shall be submitted for approval at the time the substitution is requested.

C. If substitutions are made in lieu of device specified; form, dimension, design and profile shall be submitted to the Engineer for approval.

D. Submit request for approval of substitute materials in writing to the Architect at least five days prior to bid opening.

2.2 MATERIALS

A. All materials used in this work shall be new and shall bear the inspection label of Underwriters' Laboratories Inc. or certification by other recognized laboratory.

B. The published standards and requirements of the Telecommunications Industries Association (TIA), National Electrical Manufacturers Association (NEMA), the American National Standard Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), and the American Society of Testing Materials (ASTM), are made a part of these Specifications and shall apply wherever applicable.

C. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.

D. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer or partner manufacturers that offer a certified solution.

E. Components of an assembled unit need not be products of the same manufacturer, but must offer a certified end-to-end solution.

F. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.

G. Components shall be compatible with each other and with the total assembly for the intended service.

H. The contractor shall be responsible for the delivery, receipt, and safe storage on site of all Electronic Safety and Security systems materials and equipment to the job site until the job is completed and the owner accepts the equipment or installation. Replace any damaged materials or equipment.

I. Records shall be kept of all materials and equipment delivered to the job site in the form of shipping manifests, bills of laden or signed receipts.

J. At the end of the installation all remaining Electronic Safety and Security systems materials and equipment will be inventoried and turned over to the owner.

PART 3 - EXECUTION

3.1 EXAMINATION OF CONDITIONS

A. Prior to the start of work, the Contractor shall carefully inspect the installed work of other trades and verify that such work is complete to the point where installation may properly commence. Start of work indicates acceptance of conditions.

B. Install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.

C. In the event of a discrepancy, immediately notify the Project Engineer and owner.

D. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

3.2 PROTECTION OF SYSTEMS AND EQUIPMENT

A. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.

B. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering the sides with securely fastened protective rigid or flexible waterproof coverings.

C. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum cleaned both inside and outside before testing, operating or painting.

D. As determined by the Owner or Engineer, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Owner or Engineer shall be final.

E. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with the same quality of paint and workmanship as used by the manufacturer.

3.3 ACCESS TO EQUIPMENT

A. Equipment shall be installed in location and manner that will allow convenient access for maintenance and inspection.

B. Working spaces shall be not less than specified in the National Electrical Code (NEC).

C. Where the Project Manager determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the Project Manager, at no additional cost to the Owner. “Conveniently accessible” is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.

3.4 CLEANING

A. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by communications work.

B. Remove dust and debris from interiors and exteriors of electrical equipment. Clean accessible current carrying elements prior to being energized.

3.5 COMPLETION

A. General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.

B. Results Expected: Systems shall be complete and operational and controls shall be set and calibrated. Labeling, testing, start-up and cleaning work shall be complete.

C. Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this Specification shall be delivered to the Owner.

3.6 TESTING AND VERIFICATION

A. See specific Division 28 section for testing parameters of Security sub-systems.

B. The Contractor shall verify that requirements of this Specification are met. Verification shall be through a combination of analyses, inspections, demonstrations and tests, as described below.

C. Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the Specifications. Inspection may require moving or partially disassembling the item to accomplish the verification, included as part of the work at no additional cost to the Owner.

D. The Contractor shall verify by formal demonstrations or tests that the requirements of this Specification have been met. The Contractor shall demonstrate that the Electronic Safety and Security systems, components and subsystems meet Specification requirements in the “as-installed” operating environment during the “System Operation Test.” Even though no formal environmental testing is required, the Contractor shall measure and record temperature, humidity and other environmental parameters and the environmental conditions, which were encountered during the “System Operation Test.”

E. The Contractor shall carefully plan and coordinate the final acceptance tests so that tests can be satisfactorily completed. The Contractor shall provide necessary instruments, labor and materials required for tests, including the equipment manufacturer's technical representative and qualified technicians in sufficient numbers to perform the tests within a reasonable time period.

F. The Contractor shall satisfy all items detailed in the final acceptance check-off list (punch list). The list shall be a complete representation of specified installation requirements. At the time of final acceptance punch list items shall be corrected until the system is found to be acceptable to the Owner and the Project Manager.

G. After the Contractor systems have been installed and tested, the completed test plan shall be signed by the Security System Contractor Project Manager and submitted for approval.

3.7 MAINTENANCE SERVICE

A. The Contractor shall furnish service and maintenance of each system for one (1) year from date of acceptance by the Owner.

1. No charges shall be made by the Installer or Contractor for any labor, equipment, materials, or associated services during this period to maintain functions of the system.
2. Respond to trouble call within twenty-four (24) hours after receipt of such call.

B. The Contractor shall, at the Owner's request, make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

C. The system manufacturer shall maintain engineering and service departments capable of rendering advice regarding installation and final closeout of the system.

END OF SECTION 28 00 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 28 05 00
COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceways and cables.
2. Sleeve seals.
3. Grout.
4. Common electronic safety and security installation requirements.

1.2 SUBMITTALS

A. Product Data: For sleeve seals.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.

c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Electronic safety and security penetrations occur when raceways, pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 28 05 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 28 05 13
CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. UTP cabling (for POE devices).
2. Wiring for access control.
3. Identification products.

1.2 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. EMI: Electromagnetic interference.

C. IDC: Insulation displacement connector.

D. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

E. RCDD: Registered Communications Distribution Designer.

1.3 SUBMITTALS

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

B. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

C. Source quality-control reports.

D. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing for UTP cabling installation.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of UTP cable for open and short circuits.

1.6 PROJECT CONDITIONS

A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.

1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.

B. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Support of Open Cabling: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

B. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceways and Boxes." Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches mounted 6” Above Finished Floor, AFF. Comply with requirements for plywood backing panels in Division 6 Section "Rough Carpentry".

2.3 UTP CABLE

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

1. Systimax (B.O.D.)
2. Panduit Corp.
3. Approved equal

B. Description: 100-ohm, Category 6, 4-pair UTP, covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, General Purpose: Type CM or CMG; or MPP, CMP, MPR, CMR, MP, or MPG.
b. Communications, Plenum Rated: Type CMP or MPP, complying with NFPA 262.
c. Communications, Riser Rated: Type CMR; or MPP, CMP, or MPR, complying with UL 1666.
d. Communications, Limited Purpose: Type CMX; or MPP, CMP, MPR, CMR, MP, MPG, CM, or CMG.
e. Multipurpose: Type MP or MPG; or MPP or MPR.
f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
g. Multipurpose, Riser Rated: Type MPR or MPP, complying with UL 1666.

2.4 UTP CABLE HARDWARE

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

1. Systimax
2. Panduit Corp.
3. Approved equal

B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

C. Connecting Blocks: 110-style for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

2.5 IDENTIFICATION PRODUCTS

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

1. Panduit Corp.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Division 26 Section "Electrical Identification."

2.6 SOURCE QUALITY CONTROL

A. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

B. Factory test UTP cables according to TIA/EIA-568-B.2.

C. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA/EIA-568-B.3.

D. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

A. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

B. Comply with requirements in Division 26 Section "Raceways and Boxes" for installation of conduits and wireways.

C. Install manufactured conduit sweeps and long-radius elbows whenever possible.

D. Pathway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 2 inchesabove finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inchdimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for installation of supports for pathways, conductors and cables.

3.3 WIRING METHOD

A. Install wiring in metal raceways and wireways. Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 1 inch, unless noted otherwise on plans. Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Install wiring in raceways except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 1 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.

C. Install cable, concealed in accessible ceilings, walls, and floors when possible.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.4 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.

C. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inchesand not more than 6 inchesfrom cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

D. UTP Cable Installation: Install using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.

1. Comply with TIA/EIA-568-B.2.
2. Install 110-style IDC termination hardware unless otherwise indicated.
3. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inchesabove ceilings by cable supports not more than 60 inchesapart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 POWER AND CONTROL-CIRCUIT CONDUCTORS

A. 120-V Power Wiring: Install according to Division 26 Section "Conductors and Cables" unless otherwise indicated.

B. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.6 CONNECTIONS

A. Comply with requirements in Division 28 Section "Digital Addressable Fire- Alarm System" for connecting, terminating, and identifying wires and cables.

3.7 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Through-Penetration Firestop Systems."

B. Comply with TIA-569-B, "Firestopping" Annex A.

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.8 GROUNDING

A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding."

3.9 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Electrical Identification" and Division 27 Section “Identification for Communications Systems”.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 28 05 13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 28 08 00
COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 28 – Security Systems shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the equipment and execution requirements relating to Commissioning of Communications.

C. Equipment specifications, general considerations, and guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - TESTING

2.1 TESTING REQUIREMENTS

A. General:

1. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA-568-C.0, ANSI/TIA-568-C.1, and/or ANSI/TIA-1152. All conductors/strands of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors/strands in all cables installed.

B. Copper Testing:

1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category 6 performance. Horizontal balanced twisted pair cabling shall be tested using a level IIe, III, or IV test unit for Category 6 performance compliance.
2. Continuity - Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail as indicated by the test unit and referenced to the appropriate cable identification number and circuit or pair

number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.

3. Length - Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA-568-C.2 Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.
4. Approved tester is as follows:
   Fluke DTX

C. Test Results:

1. Test documentation shall be provided in 3 hard copies and 3 electronic copies on disk as part of the as-built package. The disk shall be clearly marked on the outside front cover with the words “Project Test Documentation,” the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair (or strand) and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.
2. The field test equipment shall meet the requirements of ANSI/TIA-568-C.2, ANSI/TIA-568-C.3, and/or ANSI/TIA-1152.
3. Three bound printouts generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package. These CDs shall contain the electronic equivalent of the test results as defined by the Specification and be of a format readable from Microsoft Word.
4. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

PART 3 - DOCUMENTATION, AS-BUILTS, TRAINING AND RECORDS

3.1 DOCUMENTATION AND AS-BUILTS

A. As-Built record documentation for communications work shall include:

1. Cable routing and identification
2. End user outlet labeling
3. System function diagrams
4. Manufacturers' description literature for equipment
5. Connection and programming schedules as appropriate
6. Equipment material list including quantities
7. Spare parts list with quantities
8. Details not on original Contract Documents
9. Test results
10. Warranties
11. Release of liens

B. The Contractor shall provide and maintain at the site a set of prints on which shall be accurately shown the actual installation of all work under this section, indicating any variation from contract drawings, including changes in pathways, sizes, locations and dimensions. All changes shall be clearly and completely indicated as the work progresses.

C. Progress prints shall be available for inspection by the Owner or any of his representatives and may be used to determine the progress of communications infrastructure work.

D. At the completion of the work, prepare a new set of as-built drawings, of the work as actually noted on the marked-up prints, including the dimensioned location of all pathways.

E. Furnish as-built drawings and documentation to the Project Manager. As-built drawings shall be generated in AutoCad 2006 or later. Submit 3 copies of as-built drawings electronically on C.D. and hard copy.

3.2 OPERATIONS AND MAINTENANCE MANUAL

A. After completion of the work, the Contractor shall furnish and deliver to the Engineer three (3) copies of a complete Operations & Maintenance Manual. A system wiring diagram shall be furnished for each separate system.

B. The manual shall be subdivided into separate sections with tab dividers to identify subsystems of the integrated system. Reference appropriate Specification sections.

C. Provide the following additional information for each electronic system. Information shall be edited for this project where applicable.

1. Operations manuals for components and for systems as a whole.
2. Maintenance manuals for components and for system as a whole.
3. Point-to-point diagrams, cabling diagrams, construction details and cabling labeling details.
4. List of spare parts, materials and suppliers of components. Provide name, address and telephone number for each supplier.
5. Emergency instructions for operational and maintenance requirements.
6. Delivery time frame for replacement of component parts from suppliers.
7. Recommended inspection schedule and procedures for components and for system as a whole.
8. List of spare parts, materials and suppliers of components. Provide name, address and telephone number for each supplier.
9. Complete “reviewed” shop drawings and product data for components and system as a whole.
10. Troubleshooting procedures for each system and for each major system component.

3.3 TRAINING

A. The Contractor shall be responsible for training of facility personnel. Training shall take place after occupancy and before acceptance and shall include programs for on-site operations and maintenance of technology and communications systems. Training shall be for not more than ten (10) people, shall be held at the Owner's site and shall be of sufficient duration and depth to ensure that the trained personnel can operate the

installed systems and can perform usual and customary maintenance actions. The contractor shall record the training and provide (3) DVD copies of the training to the project manager.

3.4 WARRANTY

A. General:

1. All equipment is to be new and warranted free of faulty workmanship and damage.
2. Replacement of defective equipment and materials and repair of faulty workmanship within 24 hours of notification, except emergency conditions (system failures), which must be placed back in service within eight (8) hours of notification, all at no cost to the Owner.
3. The minimum warranty provisions specified shall not diminish the terms of individual equipment manufacturer's warranties.

B. CCTV Surveillance System:

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed CCTV Surveillance System. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

C. Pathway and Support Infrastructure:

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed Pathway & Support Infrastructure. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

END OF SECTION 28 08 00

SECTION 28 13 00
ACCESS CONTROL SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 GENERAL REQUIREMENTS

A. Complete Access Control system interfaced into the campus wide system, as shown on the drawings and specified herein, includes supplementary or miscellaneous items, equipment and devices incidental to or necessary for a complete system installation, system testing, system programming, and owner employee training. Contactor responsible for all equipment, wiring, cabling, low voltage conduit, and programming necessary to provide 100% functional Access Control system.

1.3 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 door raceway preparations to include boxes, and conduits stubbed to above the ceiling on the secured side of the portal shall be performed by the electrical contractor under Division 26 of the specifications.

C. The network cabling equipment will be installed, tested, and commissioned under Division 27 Specification, and associated drawings. This includes fiber, POE switches, raceway, cabling, labels, and terminations.

D. The door hardware will be provided by the door contractor under Division 08 of the specifications.

1.4 STANDARDS

A. Specifications, Standards and Codes: All work shall be in accordance with the following:

1. The 2011 edition of the National Electrical Code (NFPA 70)
2. American National Standards Institute (ANSI)
3. National Electrical Manufacturers Association (NEMA)
4. Telecommunications Industries Association (TIA)
5. Electronic Industries Association (EIA)
6. Institute of Electrical & Electronics Engineers (IEEE)
7. Underwriters Laboratories (UL)
8. American Standards Association (ASA)
9. Building Industry Consulting Services International (BICSI)
10. Federal Communications Commission (FCC)
11. Occupational Safety and Health Administration (OSHA)

12. American Society of Testing Material (ASTM)
13. Americans with Disabilities Act (ADA)
14. Local city and county ordinances governing electrical work
15. In the event of conflicts, the more stringent provisions shall apply.

1.5 DEFINITIONS

A. Credential: Data assigned to an entity and used to identify that entity.

B. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.

C. Identifier: A credential card, keypad personal identification number or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

D. Location: A Location on the network having a PC-to-controller communications link, with additional Controllers at the Location connected to the PC-to-controller link with TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.

E. PCI Bus: Peripheral Component Interconnect. A peripheral bus providing a high-speed data path between the CPU and peripheral devices such as monitor, disk drive, or network.

F. RAS: Remote access services.

G. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

H. Interface: The ability to provide operational functions between two/multiple separate systems by the use of relay logic along with specific wiring connected between the systems to provide the function.

I. Integration: The ability to provide operational functions between two/multiple systems by the use of open architecture computer software and the existing communication CAT cable.

1.6 SCOPE OF WORK

A. Conceptual Design:

1. The Access System will be of an open-architecture design to integrate along with multiple systems. The system will utilize smart card technology and readers as specified in this specification.
2. Control Equipment: The main access control equipment cabinets, along with the servers, POE switch(es), UPS power, and fiber connections will be provided in the MDF room of the Building
3. Monitoring Work Station: provided in the WATCH/REPORT room of the main building and at any other PC location with the system software and network access installed for system management.

4. Network Equipment:

    a. The remote Access Control equipment cabinet along with the fiber connections, POE switch(es), and UPS power will be provided in the MDF and/or IDF room(s) of each building.
    b. The cabinets, fiber, POE switch(es), CAT cable, labeling, and connections are to be provided by the Network Communication Contractor to connect the door controllers to the control equipment.

5. Door Hardware: The door hardware strikes, maglocks, door operators will be provided by the door contractor under section 8.
6. Door Hardware Raceways: The raceway from the door controllers to the door equipment to be provide by the electrical contractor under Division 16 of the specifications.
7. Access Equipment: The access equipment readers, REX buttons, REX motions door status, door secure sensor will be provided under this section of the specification.

B. This section includes access control equipment consisting of door controller equipment connected to the network to operate the door access equipment.

C. The door control equipment and network will be connected to the access control server located in the building. The installation will consist of a software licenses and equipment. The contractor shall review the existing access control equipment and include any necessary equipment to maintain the intended design criteria.

D. The Access Control system shall be integrated with:

1. Fire Alarm System.

E. The integration of the above systems will include at a minimum data transfer of access card number, assigned card holder name and details, card holder photo, access permissions, schedule permissions, alarm inputs, video caption during alarms, fire alarm door release lockdown functions by door and groups of doors.

1. As part of this specification a factory trained certified integrator of the supplied equipment will work along with the owner representative, and the integrators of the other systems to provide:

    a. A SOP of the system operations.
    b. The system integrators will work together to integrate their system with the other specified systems to meet the SOP requirements.

1.7 SUBMITTALS

A. Product Data Sheets for each type of product indicated. Include dimensions and data features, performances, electrical characteristics, ratings, finishes, and manufacturer equipment warranty period.

B. Shop Drawings for the access control system including plans, elevations, sections, details and attachments to other work.

1. Detail equipment locations with specific equipment provided.
2. Functional Diagram Block showing single line connections between the access door hardware and the server equipment.

3. Dimensional plans of the equipment racks, control equipment, signal transmission along with service clearances.
4. UPS Power Feed and Back-up Power Calculations
5. UPS Dedicated circuit feed
6. Wire size calculations for each door cable run.

1.8 SPARE COMPONENTS

A. Provide the owner with 10% of the total number of door controllers for each type of controller that is provided by the Access Control Contractor under this project.

1.9 QUALITY ASSURANCE

A. Electrical components, devices, and accessories will be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for the intended location and application.

B. Comply with all laws, ordinances, rules, regulations and orders of public authorities having jurisdiction over this part of work. This includes but is not limited to having all necessary licenses, permits and inspections as required by local, state or federal authorities.

C. Access Control equipment standards: Electronic Industries Associations (EIA), IEEE. All equipment shall be listed and labeled as UL Listed and Approved to meet state electrical requirements.

D. Electronic data exchange of the access control software system shall utilize open architecture for the interface of video, input and output data transfer.

E. Installer Qualifications:

1. Security Systems Integrator must have personnel with a Certified Security Specialist Certification on staff and assigned to this project.
2. Security Systems Integrator must be an Authorized Dealer with the manufacturer of proposed system and certified on the equipment.
3. Within ten (10) business days of receiving the Notice to Proceed, the Integrator shall submit a list of all personnel assigned to the project. Identify their duties and their office address and telephone number.
4. Keep the job adequately staffed at all times. Unless illness, loss of personnel or other circumstances beyond the control of the contractor, maintain the same individual in charge throughout.
5. All work done under this contract shall be performed in accordance with the most recent issue of the Standard Building Code, The National Electrical Code (NFPA 70), and the National Electrical Safety Code (NESC) and any applicable local or state required codes and standards. Where there is a perceived conflict between a standard and the contract documents, the Contractor shall perform the work as directed by the Consultant. Where no specific method or form of construction is called for in the Contract Documents, the Contractor shall comply with code requirements when carrying out such work. Drawings pertaining to this specification shall be considered as a part of said specification and shall be a part of the bid documents.

7. Procure and pay for all necessary permits, licenses and inspections and observe any requirements stipulated therein. Conform in all trades with all local regulations and codes.
8. Provide weekly status reports shall also be provided one day prior to the onsite project meetings starting after the Letter of Intent and continuing through project close-out. Reports shall be submitted electronically to the CM, Architect, and Consultant. It shall state project status in the field, scheduling, purchasing, and any concerns. It will not be a formal means of communication, and will not replace the requirement of RFIs, product submittals, proposed change orders, schedule issues, etc.

1.10 SYSTEM MANUFACTURER

A. Key Requirements:

1. All Products for Access Control System will match existing district wide system.

PART 2 – PRODUCTS

2.1 ACCESS CONTROL SYSTEM COMPONENTS

A. Card Readers, Keypads and Access Control Cards shall be provided in the encoding technology and quantities specified in the contract documents and drawings. Door contacts switches, request-to-exit devices, electric locks and strikes, local alarm horns, status indicators and other devices shall also be provide as shown on Contract Drawings

B. Readers:

1. Readers provide shall be HID technology.
2. Quantity and location of readers shall be as specified in contract documents and drawings.

C. Door Contact Switches:

1. Recessed Mount magnetic contact switches shall be provided to monitor the status of each card reader controller door and auxiliary door as noted on the contract drawings.
2. Recessed devices shall be used where required.
3. Quantity and location of the door contact switches shall be as specified in contract documents and drawings.

D. Request-to-Exit Devices:

1. Request-to-exit devices shall be provided to allow a person to exit an access controlled door.
2. Quantity and location of request-to-exit devices shall be as specified in contract documents and drawings.

E. Electric Locking Devices:

1. Electric locking devices shall be provided to lock (secure) and unlock (unsecured) each card reader controlled door and auxiliary door as noted in the contract drawings

2. Electronic Locking Devices must be capable of being activated from the Networked Intelligent Controller
3. Door electric controlling devices shall be either Magnetic Locks or electric strikes as specified in contract documents and drawings.
4. Quantity and location of electric locking devices shall be as specified in contract documents and drawings.

2.2 MONITORING EQUIPMENT

A. Provide programming to interface to existing system.

2.3 NETWORK EQUIPMENT

A. See Section 27 of the Specifications and T-series drawings for device locations and quantities for the following:

1. Copper and Fiber outlets
2. Copper and Fiber cable, including patch cables
3. LAN POE Switches
4. Equipment Cabinets
5. System Application Computer and Server.

2.4 DOOR HARDWARE (See Section 8 of this Specification)

A. Exterior Panic Hardware Doors: (Door Type I):

1. Consists of panic hardware electronic
2. Shear Maglocks with door secure sensors

B. Interior Doors: (Door Type II):

1. Door strikes

C. Interior Doors: (Door Type (III):

1. 5/2 door electric hinge

2.5 ACCESS CONTROL EQUIPMENT

A. Lock Down Power Supply (Altronics):

1. Rack mounted standard EIA 19 rack-mount chassis
2. Allow RU space on top and bottom for ventilation
3. 6 amp 12 Vdc or 24Vdc is W16 of fused or PTC protected outputs
4. 115 VAC 50/60 Hz input
5. Individually selectable Fail Safe or Fail Secure power outputs
6. Fire Alarm disconnect input.

a. With NO or NC dry contact input or polarity reversal input from FACP circuit. Fire Alarm disconnect is individually selectable for any or all of the outputs.

7. AC fail supervision

B. HID i-Class Reader:

1. The card readers supplied for the access control portals will be HID i-class smart card readers transmitting a weigand output as follows:

   a. Standard Door Application: HID i-Class Model R40
   b. Mullen Door Application: HID i-Class Model R10
   c. Long Range Reader Application: HID i-Class Model R90 (up to 18")

2. No substitutions will be permitted.
3. Contactless smart card reader shall comply with the following 13.56 MHz related standards and ensure product compatibility with the access control system.

   a. ISO 15693
   b. ISO 14443A
   c. ISO 14443B

C. Door Status Sensors:

1. Equipment Design Criteria:

   a. The door status sensor shall be of a concealed recessed design that is compatible and operational with the access control door controller. It will function properly with the door and frame assembly without causing restriction of operation of the door or improper status or alarm signals.
   b. The door status sensor will be installed concealed in the door and door frame of each access control operated door assembly.
   c. Electrical Rating: The door status sensor will be listed and rated to operate with the access control door controller assembly.

D. REX Motion Detector:

1. Basis of Design: The REX motion, when required, will be connected to the door controller and mounted above the door that it is permitting exit to. It will be powered and controlled by the door controller.
2. The REX motion will be listed and rated for the location that it will be installed as follows:

   a. Indoor controlled environment
   b. Indoor uncontrolled environment
   c. Outdoor
   d. Hazardous location

3. Electrical Rating:

   a. Power: The REX motion detector will match the door controller voltage and have an amp draw of less than .250 amps. The REX motion detector control voltage and power shall be rated by the voltage and power provided by the door controller that it is being controlled by.

E. Shear Maglocks (Lockdown):

1. Basis for Design: Electromagnetic shear locks will be installed in all exterior doors and any other doors indicated on the drawing to have a lockdown function. The shear lock will be provided with a door lock sensor that will be connected to the door controller. The shear lock will be secured upon request of the Global Security Management Software.

2.6 OPERATIONAL OBJECTIVES

A. The Access Control System shall provide the following card access control operational objectives:

1. Controlled entry, via access card readers, of only authorized personnel to secured areas based on cardholder information entered and stored in the system database.
2. The access request response time from card presentation, database verification, to electric lock unlock shall be no more than one second in normal operating mode on a fully loaded system.
3. All access requests, both authorized and denied, shall be sent to the host for storage and annunciation, as required, with cardholder number, name, and access point/area where access was attempted or gained.
4. The software package shall provide for local Anti-Passback. The system shall also be capable of providing timed Local Anti-Passback for security areas, and the time shall be capable of being selected by the operator.
5. The system shall provide for automatic lock/unlock of access-controlled doors on a scheduled basis using time schedule.
6. Each card and cardholder shall be entered into the database prior to their use. Each card can be manually disabled at any time without the requirement to delete the card. Each card can then be subsequently re-enabled at a later time.
7. Cards records shall include the entry of activation and deactivation dates to provide for the automatic enabling and expiring of the card record.
8. The operating mode of access controlled doors shall be indicated as locked, unlocked, or controlled. The door status shall be indicated as open or closed.
9. The system shall provide for the monitoring of the reader controlled door position in order to detect and report Door Forced Open and Door Held Open alarm conditions. Door Held Open condition shall be based on a user-adjustable time period. The act of opening the door shall initiate the door timer, and also cause the immediate reset of the door lock.
10. The system shall provide the capability to unlock the door and/or mask (shunt) the door alarm, as user-configured, via a request-to-exit door motion sensor device or exit push-button. The capability shall be software programmable to allow selectable exit reporting.
11. All system controlled electric locks shall be capable of being unlocked via a client workstation and/or request-to-exit device.

B. Alarm Monitor Points:

1. Each supervised security system input point (door contacts, motion detectors, and other associated alarm inputs) shall have a user-specified 16 character, minimum, identifier.
2. The system shall allow masking and unmasking of alarm points manually by the operator, automatically by time schedule, or, where required, by a cardholder from a reader keypad. The system shall not allow an alarm point to be masked if the alarm point is in a “trouble” condition.

3. All alarm points shall be individually annunciated upon any change of state. Alarm contacts shall not be connected in parallel or series in zones, unless specifically shown on the contract drawings. Double doors with alarm contacts on each leaf of the double door unit may be wired in series, for that double door unit.
4. The system shall provide for special purpose alarm monitoring and/or transaction reporting for specific events, such as, but not limited to the following:

    a. Duress condition at a card reader
    b. Anti-Passback
    c. Rejected access request
    d. Card Reader Tampered
    e. Card reader Off-Line
    f. Controller Cabinet Tampered
    g. AC Power Failure
    h. Controller Communications Failure
    i. Low battery at UPS power supply

5. Unacknowledged alarm reports (an alarm condition that has not been acknowledged within a user-specified time period at a client workstation) shall initiate a Special alarm message to a designated alternate client workstation on the system.

C. Relay Output Points:

1. Each security system output point (door lock, gate controller, and other associated relay outputs) shall have a user-specified 16 character, minimum, text identifier. Each point shall be software programmable for activation and deactivation.
2. The system shall allow activation and deactivation of output points manually by the operator, automatically by time schedule, automatically by the activation of an alarm point.

2.7 CABLES

A. General Cable Requirements: Comply with specification requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security" and as recommended by system manufacturer for integration requirement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with TIA/EIA 606-A, "Administration Standard for Commercial Telecommunications Infrastructure."

C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Owner's requirements. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.

1. Record setup data for control station and workstations.
2. For each Location, record setup of controller features and access requirements.
3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
5. Assign action message names and compose messages.
6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
7. Prepare and install alarm graphic maps.
8. Develop user-defined fields.
9. Develop screen layout formats.
10. Propose setups for guard tours and key control.
11. Discuss badge layout options; design badges.
12. Complete system diagnostics and operation verification.
13. Prepare a specific plan for system testing, startup, and demonstration.
14. Develop acceptance test concept and, on approval, develop specifics of the test.
15. Develop cable and asset-management system details.

D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final documents. Use final documents to set up system software.

3.3 CABLING

A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

B. Install cables and wiring according to requirements in Section 28 05 13 "Conductors and Cables for Electronic Safety and Security."

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

E. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and fiber-optic rating of components, and that ensure Category 6 and fiber-optic performance of completed and linked signal paths, end to end.

F. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

G. Install end-of-line resistors at the field device location and not at the controller or panel location.

3.4 CABLE APPLICATION

A. Comply with TIA 569-B, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. TIA 232-F Cabling: Install at a maximum distance of 50 feet.

D. TIA 485-A Cabling: Install at a maximum distance of 4000 feet.

E. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 feet, and install No. 20 AWG wire if maximum distance is 500 feet.
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 feet.

G. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of 25 feet.

3.5 GROUNDING

A. Comply with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.6 INSTALLATION

A. Install card readers, keypads, push buttons, and devices as indicated on the drawings.

3.7 SYSTEM SOFTWARE AND HARDWARE

A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 6 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-B.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-B.1.
2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 DOCUMENTATION AND AS-BUILTS

A. As-Built record documentation for communications work shall include:

1. Cable routing and identification
2. End user outlet labeling
3. System function diagrams
4. Manufacturers' description literature for equipment
5. Connection and programming schedules as appropriate
6. Equipment material list including quantities
7. Spare parts list with quantities
8. Details not on original Contract Documents
9. Test results
10. Warranties
11. Release of liens

B. The Contractor shall provide and maintain at the site a set of prints on which shall be accurately shown the actual installation of all work under this section, indicating any variation from contract drawings, including changes in pathways, sizes, locations and dimensions. All changes shall be clearly and completely indicated as the work progresses.

C. Progress prints shall be available for inspection by the Owner or any of his representatives and may be used to determine the progress of communications infrastructure work.

D. At the completion of the work, prepare a new set of as-built drawings, of the work as actually noted on the marked-up prints, including the dimensioned location of all pathways.

E. Furnish as-built drawings and documentation to the Project Manager. As-built drawings shall be generated in AutoCad 2006 or later. Submit 3 copies of as-built drawings electronically on CD and hard copy.

3.10 OPERATIONS AND MAINTENANCE MANUAL

A. After completion of the work, the Contractor shall furnish and deliver to the Engineer three (3) copies of a complete Operations & Maintenance Manual. A system wiring diagram shall be furnished for each separate system.

B. The manual shall be subdivided into separate sections with tab dividers to identify subsystems of the integrated system. Reference appropriate Specification sections.

C. Provide the following additional information for each electronic system. Information shall be edited for this project where applicable.

1. Operations manuals for components and for systems as a whole.
2. Maintenance manuals for components and for system as a whole.
3. Point-to-point diagrams, cabling diagrams, construction details and cabling labeling details.
4. List of spare parts, materials and suppliers of components. Provide name, address and telephone number for each supplier.
5. Emergency instructions for operational and maintenance requirements.
6. Delivery time frame for replacement of component parts from suppliers.

7. Recommended inspection schedule and procedures for components and for system as a whole.
8. List of spare parts, materials and suppliers of components. Provide name, address and telephone number for each supplier.
9. Complete “reviewed” shop drawings and product data for components and system as a whole.
10. Troubleshooting procedures for each system and for each major system component.

3.11 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.12 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

3.13 TRAINING

A. The Contractor shall be responsible for training of facility personnel, See Section 017900 "Demonstration and Training." Training shall take place after occupancy and before acceptance and shall include programs for on-site operations and maintenance of technology and communications systems.

B. Training shall be for not more than ten (10) people, shall be held at the Owner's site and shall be of sufficient duration and depth to ensure that the trained personnel can operate the installed systems and can perform usual and customary maintenance actions.

C. The contractor shall record the training and provide (3) DVD copies of the training to the project manager.

D. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

3.14 WARRANTY

A. General:

1. All equipment is to be new and warranted free of faulty workmanship and damage.
2. Replacement of defective equipment and materials and repair of faulty workmanship within 24 hours of notification, except emergency conditions (system failures), which must be placed back in service within eight (8) hours of notification, all at no cost to the Owner.
3. The minimum warranty provisions specified shall not diminish the terms of individual equipment manufacturer's warranties.

B. Access Control System:

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed Access Control System. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

3.15 IDENTIFICATION

A. In addition to requirements in this article, comply with applicable requirements in Section 26 05 53 "Identification for Electrical Systems" and Section 27 05 53 Identification for Communications Systems and with TIA/EIA 606-A.

B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.

C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

D. At completion, cable and asset management software shall reflect as-built conditions.

END OF SECTION 28 13 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 28 23 00
CCTV AND VIDEO SURVEILLANCE

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.

B. This document describes the products and execution requirements relating to the Security CCTV and Video Surveillance System.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

D. Related Specifications:

1. Division 00
2. Division 01
3. Division 27
4. Division 28

E. Applicable requirements of the Division 27 and 28 Design Criteria shall all be considered a part of this Division and shall have the same force as if written herein full.

1.2 SUMMARY

A. This document describes the equipment and execution requirements relating to the Security CCTV and Video Surveillance System.

B. In general, you will be known throughout the documents as “Video Surveillance System contractor, CCTV or VSS Installer, CCTV or VSS integrator, or the Owner’s Vendor.”

C. The installation shall include all accessories and appurtenances required to provide a complete and fully operational system. Any materials not specifically mentioned in these specifications, but required for a finished and functional installation shall be furnished and installed at no additional cost to the Owner. Provide all items not indicated on the drawings or mentioned in the specifications that are necessary, required or appropriate for this work to provide complete, stable and safe operation.

D. All equipment shall be installed as shown on the drawings and in strict accordance with the specifications. Any errors, conflicts, or omissions discovered in the specifications or the drawings shall be submitted in writing to the engineer for clarification. Installation shall not proceed until questions have been resolved.

E. The contractor shall deliver, install, program, test, start-up, checkout and otherwise substantially complete the systems within the Construction Manager’s construction schedule. The system shall be available for a substantial completion inspection by the Owner and the Consultant on the scheduled substantial completion inspection date.

1.3 WORK INCLUDED

A. The work to be done under this section of the Specifications shall include the furnishing of labor, material, equipment and tools required for the complete installation of the work indicated on the Drawings or as specified herein.

B. All materials, obviously a part of the Security Infrastructure and necessary to its proper operation, but not specifically mentioned or shown on the Drawings, shall be furnished and installed without additional charge.

C. The Drawings and Specifications are complementary to each other and what is called for by one shall be as binding as if called for by both. If a discrepancy exists between the Drawing and Specifications, the higher cost shall be included, and the engineer shall be notified of the discrepancy.

D. The Contractor shall be responsible for full coordination of all work to be accomplished as part of the Security CCTV and Video Surveillance System project as well as all programming to interface to existing campus wide system.

1.4 QUALITY ASSURANCE

A. Comply with all laws, ordinances, rules, regulations and orders of public authorities having jurisdiction over this part of work. This includes but is not limited to having all necessary licenses, permits and inspections as required by local, state or federal authorities.

B. Video Surveillance equipment standards: Electronic Industries Associations (EIA), IEEE. All equipment shall be listed and labeled as UL Listed and Approved to meet state electrical requirements.

1.5 SYSTEM MANUFACTURER

A. Key Requirements:

1. All Products for Video Surveillance System will match existing system, unless otherwise specified by owner.

    a. Manufacturer – Verkada brand – PoE.

B. Manufacturer Warranty and Support:

1. Manufacturer shall provide technical support at no charge to assist owner’s request.
2. Manufacturer shall offer a three year warranty on all products except digital recorders, which shall be one year.
3. Warranty for equipment shall begin at the time of equipment installation, and not the ship date of equipment.
4. Manufacturer shall offer immediate Advance Replacements of warranty items at no additional charge.

PART 2 – PRODUCTS

2.1 GENERAL

A. Acceptable Manufacturer: Match existing on site system components.

2.2 CONTROL UNIT AND PANELS

A. The control unit/software shall be mounted in the Control Room. Termination Panels shall be mounted in the Building MDF as shown on the drawings. The cabinet or panels shall be labeled “VIDEO SURVEILLANCE SYSTEM”.

2.3 SYSTEM DEVICES

A. See drawings for types, requirements, and locations.

2.4 VIDEO SURVEILLANCE SYSTEM OPERATION

A. Provide new PTZ or Fixed color camera locations as shown on drawings, with head-end equipment located in the CCC Building MDF equipment cabinets.

B. Cameras shall be positioned according to drawings for best coverage of the intended area.

C. Head-end equipment shall be positioned according to drawings in a logical manor.

D. Wire and cable for each camera location shall be carefully installed to ensure that all state and local low voltage electrical codes and wiring requirements are strictly followed. Contractor shall be responsible for confirming and following all state and local electrical code requirements. Any deviation from state or local electrical code requirements shall be repaired at contractor’s expense. All power and video cable, and wire shall be installed according to state electrical code.

E. Contractor to provide ten (10) feet of extra power and video wire at both ends. All wire and cable shall be neatly dressed and tie wrapped. All wire and cable shall be terminated directly into head-end equipment with no splicing or patching.

F. As code allows, all above ceiling, secure, and exposed wire and cable shall be run without conduit and shall be considered “open cabling”. Plenum cable shall be required as low voltage electrical code dictates; otherwise non-plenum cable is acceptable. All open, non-secured, easily accessible, and visible wire and cable shall be installed in conduit and wire-mold according to codes and electrical laws.

G. The scope of the work may include a combination of the following listed equipment: new interior and exterior color fixed camera locations, new interior and exterior PTZ dome camera locations, digital recording and control system programming.

H. Installation Requirements – Install CCTV equipment with all power supplies, terminal strips, cable and other equipment as required for a complete and operating system. All programming and preliminary testing to be accomplished at the shop. Follow installation procedures and wiring recommendations of the equipment manufacturer.

I. Testing Requirements – The contractor shall perform all electrical and mechanical tests recommended by the equipment manufacturer and required in this section. Bench settings are not acceptable. Final tests and inspection shall be held in the presence of the owner.

J. Training Requirements – Provide eight hours of training of operational instruction and four hours of maintenance instruction. Seminars to be “hand on” instruction held at facility.

K. ALL cameras will be 24/7 monitoring. The recordings will be capable of storage for 7 days.

2.5 CABLE, WIRE, AND ACCESSORIES

A. Copper:

1. Homerun from each Camera to the MDF or IDF room as shown on the drawings.

B. UTP Cable shall be the same cable as the Data and Voice cabling.

PART 3 – EXECUTION

3.1 SYSTEM INSTALLATION

A. Comply with OSHA, UL 681 and NFPA 731.

B. Wall mounted in the MDF as necessary to connect to system devices. The equipment shall be installed within the MDF spaces in a logical manner.

C. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor, AFF.

D. MDF:

1. Equipment layout by Owner’s Vendor. MDF Equipment Cabinet provided by Division 27 Contractor.
2. Contractor shall terminate all cameras jacks together starting at bottom patch panel, port 48 and work backwards. Label each port as “Camera #”.

3.2 RACEWAYS AND FITTINGS

A. Electric Metallic Tubing (EMT) may be installed in interior locations only. Locknuts, bushings, and other fittings tight compression type. Below grade and in concealed locations above grade, conduit shall be either hot dip galvanized rigid steel or PVC with rigid steel elbows. PVC shall not be installed inside buildings.

B. Underground conduit shall be installed a minimum of 2’-0” below grade.

3.3 SYSTEM TEST

A. Upon completion of installation of system specified, cameras shall be completely verified and tested in the presence of the installing contractor and owner's representative by a factory-authorized representative. Results of the verification and testing shall be reported in writing to the A/E. The review and acceptance of the written report shall be a prerequisite for the acceptance of the work.

B. Provide close-out documents and Owner training, in accordance with the close-out requirements specified elsewhere, to include the following:

1. Operating Manual
2. Service Manual
3. Technical Manuals and Schematics
4. Maintenance Instructions
5. Parts Listings
6. As-Built Drawings
7. Software interface (with any required hardware interfaces between a laptop computer and control panel) with a copy of the final program
8. Operating instructions and demonstration for staff
9. The minimum number of hours of technical training for two (2) of the Owner's technicians to become factory certified in the maintenance of this system at no additional expense to the Owner.

3.4 TRAINING

A. The VSS Installer shall provide on-site training to the owners on-site and technical personnel on the operational use of the features of the system and the use of all equipment provided. The cost of training shall be included in the bid. The Owner's staff and the Consultant shall be notified prior to and may participate in training at their discretion. The VSS Installer shall provide documentation of training including names of personnel present at each training session to the Consultant prior to final acceptance.

B. Training shall include a "walk-through" of the system for location and orientation, a discussion of overall system concepts and configuration, a review of the as-built drawings, a review of the system verification and acceptance documentation, and guidelines for operation and basic trouble-shooting of the System.

C. System training shall be presented in an organized and professional manner by a technician who is thoroughly familiar with the system installation for this project.

D. System training shall be conducted during regular working hours and at a time suitable to the Owner. The instructor shall provide operations manuals or any other instructional material that may enhance the training effort. The VSS Installer shall provide all material and equipment necessary to perform the training and shall utilize actual equipment in operation.

E. Video record all training sessions and deliver the electronic file to the owner (for future training).

F. After the Owner has utilized the facility for two months, follow up training shall be scheduled to resolve any questions or system functions.

3.5 WARRANTY

A. All components, parts, and assemblies supplied by the manufacturers and installed by the Contractor shall be warranted against defects in material and workmanship for a period of at least 12 months (parts and labor), commencing upon date of acceptance by Owner. A qualified factory-trained service representative shall provide warranty service.

B. Service/Maintenance:

1. System maintenance and repair of system or workmanship defects during the warranty period shall be provided by the Contractor free of charge (parts and labor).
2. Periodic testing of the system shall be carried out on a monthly or quarterly basis to ensure the integrity of the control panel, the sensing devices, and the telephone lines.
3. The installer shall correct any system defect within six hours of receipt of call from the Owner.
4. Extended service/maintenance agreements shall be offered by the Contractor for up to four years after the warranty expires. The agreement shall be renewable monthly, quarterly, or yearly.

C. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fails in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

3.6 CLOSEOUT DOCUMENTATION

A. Operation and Maintenance Manuals:

1. Quantity: Three (3) or greater quantity if required by the architectural specifications.
2. Provide O&M Manuals as required by the architectural specifications and as follows.

a. The O&M Manuals shall contain sufficient information to permit Owner personnel to operate the system with or without assistance from the Contractor.
b. The Contractor shall provide O&M Manuals covering all equipment and materials furnished under this contract.
c . The O&M Manuals shall contain all information necessary for the operation, maintenance, parts procurement, and parts replacement for the Video Surveillance system.

3. Sections: All sections shall be separated with an appropriate tabbed section divider with the appropriate number and title (typed) as follows:

a. Section 1 Cuts Sheets: Manufacturer’s original data/cut sheets for each system component.
b. Section 2 Equipment List: Typed list of each item of electrical, active equipment provided with system with brief description, serial number, and part number. Note where each item of equipment is installed (i.e. in which room or area, etc.).

c. Section 3 Factory Manuals: Manufacturer's printed Installation and Operating Manuals for each item of equipment.
d. Section 4 Warranties: Copy of Contractor's warranty.
e. Section 5 Cable Tests: All tests results for all cabling.
f. Section 6 Commissioning: All tests results.

END OF SECTION 28 23 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 28 46 21.11
ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Air-sampling smoke detectors.
5. Heat detectors.
6. Notification appliances.
7. Remote annunciator.
8. Addressable interface device.
9. Digital alarm communicator transmitter.

1.3 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FACP: Fire Alarm Control Panel.

C. NICET: National Institute for Certification in Engineering Technologies.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.

5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.

    a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    b. Show field wiring required for HVAC unit shutdown on alarm.
    c. Locate detectors according to manufacturer's written recommendations.
    d. Show air-sampling detector pipe routing.

13. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
14. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:

    a. Trained and certified by manufacturer in fire-alarm system design.
    b. NICET-certified, fire-alarm technician; Level III minimum.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:

   a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
   b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
   d. Riser diagram.
   e. Device addresses.
   f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
   g. Record copy of site-specific software.
   h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

      1) Equipment tested.
      2) Frequency of testing of installed components.
      3) Frequency of inspection of installed components.
      4) Requirements and recommendations related to results of maintenance.
      5) Manufacturer's user training manuals.

   i. Manufacturer's required maintenance related to system warranty requirements.
   j. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys and Tools: One extra set for access to locked or tamper-proofed components.
2. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.9 PROJECT CONDITIONS

A. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

B. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Automatic sprinkler system water flow.
6. Fire-extinguishing system operation.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Activate alarm communication system.
6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
7. Recall elevators to primary or alternate recall floors.
8. Activate emergency shutoffs for gas and fuel supplies.
9. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. Alert and Action signals of air-sampling detector system.
3. Independent fire-detection and -suppression systems.
4. User disabling of zones or individual devices.
5. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.

2.3 FIRE-ALARM CONTROL UNIT

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

1. Notifier.
2. Silent Knight.
3. SimplexGrinnell LP.

B. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

    a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
    b. Include a real-time clock for time annotation of events on the event recorder and printer.
    c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
    d. The FACP shall be listed for connection to a central-station signaling system service.
    e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class B.
2. Install no more than 50 addressable devices on each signaling-line circuit.
3. Serial Interfaces:

    a. One dedicated RS 485 port for central-station operation using point ID DACT.
    b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
    c. One USB port for PC configuration.

E. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Sound general alarm if the alarm is verified.
4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

F. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

G. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:

a. Elevator lobby detectors except the lobby detector on the designated floor.
b. Smoke detectors in elevator hoistway.

2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.

a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

H. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

I. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

J. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium.

K. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

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

1. AMSECO - A Potter Brand.
2. Bosch Security Systems, Inc.
3. Faraday.
4. Federal Signal Corporation.

5. Fike Corporation.
6. Fire-Lite Alarms, Inc.; a Honeywell International company.
7. Gamewell - FCI by Honeywell.
8. GE UTC Fire & Security; A United Technologies Company.
9. Keltron Corporation.
10. Mircom Technologies, Ltd.
11. Notifier.
12. Potter Electric Signal Company, LLC.
13. Siemens Industry, Inc.; Fire Safety Division.
14. Silent Knight.
15. SimplexGrinnell LP.
16. System Sensor.
17. Wheelock; a brand of Eaton.

B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.
3. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
4. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.5 SYSTEM SMOKE DETECTORS

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

1. Bosch Security Systems, Inc.
2. Faraday.
3. Fenwal Protection Systems; A UTC Fire & Security Company.
4. Fire-Lite Alarms, Inc.; a Honeywell International company.
5. Gamewell - FCI by Honeywell.
6. GE UTC Fire & Security; A United Technologies Company.
7. Gentex Corporation.
8. Harrington Signal, Inc.
9. Keltron Corporation.
10. Mircom Technologies, Ltd.
11. Notifier.
12. Potter Electric Signal Company, LLC.
13. Siemens Industry, Inc.; Fire Safety Division.
14. Silent Knight.
15. SimplexGrinnell LP.
16. System Sensor.

B. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be four-wire type.

3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

C. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.6 HEAT DETECTORS

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

1. Bosch Security Systems, Inc.
2. Faraday.
3. Fire-Lite Alarms, Inc.; a Honeywell International company.
4. Gamewell - FCI by Honeywell.
5. GE UTC Fire & Security; A United Technologies Company.
6. Gentex Corporation.
7. Harrington Signal, Inc.

8. Keltron Corporation.
9. Mircom Technologies, Ltd.
10. Notifier.
11. Potter Electric Signal Company, LLC.
12. Siemens Industry, Inc.; Fire Safety Division.
13. Silent Knight.
14. SimplexGrinnell LP.
15. System Sensor.

B. General Requirements for Heat Detectors: Comply with UL 521.

1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 NOTIFICATION APPLIANCES

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

1. Federal Signal Corporation.
2. GE UTC Fire & Security; A United Technologies Company.
3. Gentex Corporation.
4. Harrington Signal, Inc.
5. Keltron Corporation.
6. Mircom Technologies, Ltd.
7. Potter Electric Signal Company, LLC.
8. Siemens Industry, Inc.; Fire Safety Division.
9. SimplexGrinnell LP.
10. System Sensor.
11. Wheelock; a brand of Eaton.

B. General Requirements for Notification Appliances: Individually addressed, connected to a signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.

C. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

D. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

E. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.

1. Rated Light Output:

    a. 15/30/75/110 cd, selectable in the field.

2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, red.

F. Audio Notification Appliances:

1. Comply with UL 1480.
2. High-Range Units: Rated 2 to 15 W.
3. Low-Range Units: Rated 1 to 2 W.
4. Mounting: semi-recessed.
5. Matching Transformers: Tap range matched to acoustical environment of speaker location.

G. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Surface cabinet, NEMA 250, Type 1.

H. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.8 ADDRESSABLE INTERFACE DEVICE

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall.

1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:

1. Operate notification devices.
2. Operate solenoids for use in sprinkler service.

2.9 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.
8. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Equipment Mounting: Install fire-alarm control unit on finished floor.

C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

D. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

E. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

F. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

G. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

H. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

I. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

J. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

K. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.3 PATHWAYS

A. Pathways shall be installed in EMT.

B. Exposed EMT shall be painted red enamel.

3.4 CONNECTIONS

A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to elevator recall system and components.
2. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
3. Supervisory connections at valve supervisory switches.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 27 05 53 "Identification for Communications Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. tests and inspections.

D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

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

END OF SECTION 28 46 21.11

Division 31

Earthwork

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 31 31 16
TERMITE CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Soil treatment.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include the EPA-Registered Label for termiticide products.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Certificates: For each type of termite control product.

C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Termiticide brand name and manufacturer.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes used, and rates of application.
6. Areas of application.
7. Water source for application.

D. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who employs workers trained and approved by manufacturer to install manufacturer's products and who is accredited by manufacturer.

1.7 FIELD CONDITIONS

A. Soil Treatment:

1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
2. Related Work: Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.8 WARRANTY

A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work consisting of applied soil termiticide treatment will prevent infestation of subterranean termites, including Formosan termites (Coptotermes formosanus). If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain termite control products from single source from single manufacturer.

2.2 SOIL TREATMENT

A. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. BASF Corporation, Agricultural Products; Termidor SC
b. Bayer Environmental Science; Premise 75 WP.
c. FMC Corporation, Agricultural Products Group; Dragnet FT.
d. Syngenta; Demon Max.

2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

1. Fit filling hose connected to water source at the site with a backflow preventer, according to requirements of authorities having jurisdiction.

3.3 APPLYING SOIL TREATMENT

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.

1. Slabs-on-Grade and Basement Slabs: Underground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
2. Foundations: Soil adjacent to and along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and along the entire outside perimeter, from grade to bottom of footing.
3. Masonry: Treat voids.
4. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.

B. Post warning signs in areas of application.

C. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

3.4 PROTECTION

A. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

B. Protect termiticide solution dispersed in treated soils and fills from being diluted by exposure to water spillage or weather until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

END OF SECTION 31 31 16

Division 32

Exterior Improvements

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 32 14 00
UNIT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Concrete pavers.
2. Setting Bed.
3. Edge restraints.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For materials other than water and aggregates.
2. For the following:

a. Pavers.
b. Edge restraints.

B. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C136.

C. Samples for Initial Selection: For each type of unit paver indicated.

1. Exposed edge restraints involving color selection.

D. Samples for Verification: For full-size units of each type of unit paver indicated. Assemble no fewer than five Samples of each type of unit on suitable backing and grout joints.

1. Exposed edge restraints.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.

1.6 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 CONCRETE PAVERS

A. Concrete Pavers, Solid Paving Units, Normal-Weight Concrete: Solid paving units made from normal-weight concrete with a compressive strength not less than 5000 psi, water absorption not more than 5 percent according to ASTM C140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C67.

B. Basis of Design Product and Manufacturer; Holland Stone Pavers.

1. Thickness: 2-3/8 inches.
2. Size: 4 inches x 8 inches.
3. Shape Rectangular.
4. Color: Match Architect’s sample.
5. Texture: Match Architect’s sample.
6. Pattern: Holland Stone Pattern 45 Degree, Herringbone.

2.3 CURBS AND EDGE RESTRAINTS

A. Aluminum Edge Restraints: Manufacturer's standard straight, 3/16-inch- thick by 4-inch- high extruded-aluminum edging with loops pressed from face to receive stakes at 12 inches o.c. and aluminum stakes 12 inches long for each loop.

1. Basis of Design Product and Manufacturer; Curv-Rite, Inc., 2000 Series Landscape Edging.
2. Finish: Mill.

2.4 ACCESSORIES

A. Compressible Foam Filler: Preformed strips complying with ASTM D1056, Grade 2A1.

2.5 AGGREGATE SETTING-BED MATERIALS

A. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying with ASTM D2940/D2940M, subbase material.

B. Graded Aggregate for Base: Sound, crushed stone or gravel complying with ASTM D2940/D2940M, base material.

C. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.

D. Stone Screenings for Leveling Course: Sound stone screenings complying with ASTM D448 for Size No. 10.

E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.

1. Provide sand of color needed to produce required joint color.

F. Drainage Geotextile: Nonwoven needle-punched geotextile fabric, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2, AASHTO M 288.
2. Apparent Opening Size: No. 40 sieve, maximum; ASTM D4751.
3. Permittivity: 0.5 per second, minimum; ASTM D4491.
4. UV Stability: 50 percent after 500 hours' exposure, ASTM D4355.

G. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 PREPARATION

A. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

B. Proof-roll prepared subgrade according to Manufacturers requirements to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for unit pavers.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

1. For concrete pavers, a block splitter may be used.

D. Joint Pattern: As selected by Architect.

E. Tolerances:

1. Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) or 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.
2. Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.

F. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
2. For metal edge restraints with top edge exposed, drive stakes at least 1 inch (25 mm) below top edge.

3.4 AGGREGATE SETTING-BED APPLICATIONS

A. Compact soil subgrade uniformly to at least 95 percent of ASTM D698 laboratory density.

B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

C. Place separation geotextile over prepared subgrade, overlapping ends and edges at least 12 inches.

D. Place aggregate subbase and base, compact to 100 percent of ASTM D1557 maximum laboratory density, and screed to depth indicated.

E. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches.

F. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.

G. Treat leveling course with herbicide to inhibit growth of grass and weeds.

H. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size unit pavers.

1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

I. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.

1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches of uncompacted pavers adjacent to temporary edges.
2. Before ending each day's work, compact installed concrete pavers except for 36-inch width of uncompacted pavers adjacent to temporary edges (laying faces).
3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches of laying face.
4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.

J. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

K. Do not allow traffic on installed pavers until sand has been vibrated into joints.

L. Repeat joint-filling process 30 days later.

3.5 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
2. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

END OF SECTION 32 14 00

SECTION 32 31 19
DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Decorative aluminum fences.
2. Swing gates.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fencing and gates.

1. Include plans, elevations, sections, gate locations, post spacing, and mounting attachment details, and grounding details.

C. Samples: For each fence material and for each color specified.

1. Provide Samples 12 inches in length for linear materials.
2. Provide Samples 12 inches square for sheet or plate materials.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Product Test Reports: For decorative metallic-coated-steel tubular picket fences, including finish, indicating compliance with referenced standard and other specified requirements.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Include 10-foot length of fence complying with requirements.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind Loading: As indicated on the Drawings

B. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

2.2 DECORATIVE ALUMINUM FENCES

A. Decorative Aluminum Fences: Fences made from aluminum extrusions.

1. Subject to compliance with requirements, provide products by one of the following:

a. Ameristar Perimeter Security; ASSA ABLOY.
b. Iron Eagle Industries, Inc.
c. Merchants Metals, LLC.

B. Posts: Square extruded tubes.

1. Line Posts: Shape as indicated; with 0.125-inch wall thickness.
2. End and Corner Posts: Shape as indicated; with 0.125-inch wall thickness.
3. Swing Gate Posts: Shape as indicated; with 0.250-inch wall thickness.

C. Post Caps: Aluminum castings that cover entire top of posts.

1. Shape: Match Existing.

D. Rails: Extruded-aluminum channels, shape as indicated; with 0.078-inch-thick sidewalls and 0.062-inch-thick top.

1. Horizontal Rail quantity: Match Existing.

E. Pickets: Extruded-aluminum tubes, : Shape as indicated; with 0.060-inch wall thickness.

1. Picket Spacing: Match Existing.

F. Fasteners: Manufacturer's standard concealed fastening system.

G. Fasteners: Manufacturer's standard tamperproof, corrosion-resistant, color-coated fasteners matching fence components with resilient polymer washers.

H. Fabrication: Assemble fences into sections by fastening pickets to rails.

1. Fabricate sections with clips welded to rails for field fastening to posts.
2. Drill clips for fasteners before finishing.

I. Finish: Baked enamel or powder coating to match Existing.

2.3 SWING GATES

A. Gate Configuration: As indicated.

B. Gate Frame Height: As indicated.

C. Gate Opening Width: As indicated.

D. Aluminum Frames and Bracing: Fabricate members from square extruded-aluminum tubes, shape to match adjacent fencing, with 0.154-inch wall thickness.

E. Frame Corner Construction: Welded.

F. Additional Rails: Provide as indicated, complying with requirements for fence rails.

G. Infill: Comply with requirements for adjacent fence.

H. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.

1. Treillage: Provide iron castings of pattern indicated between each pair of pickets. Finish as specified for adjacent fence.

I. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet wide. Provide center gate stops and cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

J. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.

1. Function: 39 - Full surface, triple weight, antifriction bearing.
2. Material: Stainless steel.

K. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

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 B221, Alloy 6063-T5.

C. Tubing: ASTM B429/B429M, Alloy 6063-T6.

D. Plate and Sheet: ASTM B209, Alloy 6061-T6.

E. Die and Hand Forgings: ASTM B247, Alloy 6061-T6.

F. Castings: ASTM B26/B26M, Alloy A356.0-T6.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 03 30 00 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size.

C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M and specifically recommended by manufacturer for exterior applications.

2.6 GROUNDING MATERIALS

A. Grounding Conductors: Size as indicated on Drawings. Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Aluminum.
2. Material on or below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, 1-5/8 inch wide and 1/16 inch thick, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Grounding Connectors and Grounding Rods: Comply with UL 467.

1. Connectors for Below-Grade Use: Exothermic-welded type.
2. Grounding Rods: Copper-clad steel.

a. Size: 5/8 by 96 inches.

2.7 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: Match Existing.

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 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 DECORATIVE FENCE INSTALLATION

A. Install fences according to manufacturer's written instructions.

B. Install fences by setting posts as indicated and fastening rails and infill panels to posts. Peen threads of bolts after assembly to prevent removal.

C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet.

D. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts and sleeves and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend 2 inches above grade. Finish and slope top surface to drain water away from post.
    b. Concealed Concrete: Top 2 inches below grade to allow covering with surface material. Slope top surface of concrete to drain water away from post.

3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.
4. Posts Set into Concrete in Sleeves: Use galvanized-steel pipe sleeves with inside diameter at least 3/4 inch larger than outside diagonal dimension of post, preset and anchored into concrete for installing posts.

    a. Extend posts at least 5 inches into sleeve.
    b. After posts have been inserted in sleeves, fill annular space between post and sleeve with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions; shape and smooth to shed water. Finish and slope top surface of grout to drain water away from post.

5. Posts Set into Voids in Concrete: Form or core drill holes not less than 3/4 inch larger than outside diagonal dimension of post.

    a. Extend posts at least 5 inches into concrete.
    b. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions. Finish and slope top surface of grout to drain water away from post.

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:

1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.

a. Gates and Other Fence Openings: Ground fence on each side of opening.

1) Bond metal gates to gate posts.
2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
3. Report: Prepare test reports of grounding resistance at each test location certified by a testing agency. Include observations of weather and other phenomena that may affect test results.

3.7 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

THIS PAGE INTENTIONALLY LEFT BLANK

Section 32 84 00
Irrigation

Part 1 General

1.01 Related Documents

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this section.
B. Related work specified or as shown elsewhere:
   1. SECTION 32 93 00 - PLANTS

1.02 SCOPE OF WORK

A. Provide all labor, materials to install the specified Irrigation System as shown on the drawings and stated in the Technical Specifications.
B. Connection to water source on property at location shown on drawings.

1.03 QUALITY ASSURANCE

A. Comply with Federal, State, County, Local and other duly constituted authorities and regulatory agencies.
B. Installation and materials shall conform to the Standards and Specifications for Turf and Landscape Irrigation Systems, Florida Irrigation Society, and the current Uniform Plumbing Code Mechanical Code, state statutes and prevailing county and/or municipal ordinances.

1.04 JOB CONDITIONS

A. Responsibility to the owner: The Contractor shall not willfully install the plumbing irrigation system as specified in the Contract Documents when it is obvious in the field that there are obstructions, grade differences and/or discrepancies in area dimensions until such conditions are brought to the attention of the Landscape Architect.
B. Utilities and Structures: Attention is directed to the fact that overhead, underground and surface utilities, structures and vegetation are in the area of the work and must be protected against damage during the progress of the work.
C. Protection and Safety: The Contractor shall be responsible and liable for the protection and safety against injury of property and persons on or about the project site during the term of his work. The contractor shall provide and properly maintain necessary warning signs and lights, barricades, railings, and other safeguards. The Contractor shall conform with the current Occupational Safety and Health Standards.
D. Site Familiarity: The Contractor shall visit the project site to examine such conditions as soils, vegetation, utilities, structures, water supply, etc., as they will influence the work pursuant to bid submission and/or contract execution.
E. Utility Connections: Location of utility connections shall be shown on the plans or as shown by the utility company. The Contractor shall include in his bid all costs for such utility connections.

1.05 SUBMITTALS

A. Submit the following:
   1. Submit proposed work schedule.
   2. Product Data: Submit two (2) copies of manufacturer's technical data and installation instructions for underground sprinkler system. Submit samples of all materials and equipment to be installed on the project.

3. Equipment: Submit a schedule of equipment to be installed to include : Automatic controller, zone control valves, gate valves, vacuum breaker valves, Pressure throttle valves, direct burial wire, pop-up rotor heads, pop-up spray heads, fixed shrub heads, bubbler heads, special purpose heads, emitter pipe, filters, fittings and valve boxes.
4. Design Data: Submit any all design data under these specifications for all areas not shown on the irrigation plans that need irrigation rework of the existing system.

1.06 DEFINITIONS AND ABBREVIATIONS

A. The Definitions and abbreviations given here below shall be considered a part of these specifications and shall apply to the interpretation and execution hereof.

1. P.S.I.: Static water pressure shall be given as pounds per square inch abbreviated: P.S.I., and where (1) P.S.I. shall equal 2.31 feet of head.
2. G.P.M.: Volume of water shall be given as gallons per minute abbreviated G.P.M.
3. Zone: A zone shall be defined as a group of heads or emitter pipes operating at the same downstream under a common control valve. A zone shall be derived as further described hereinafter on the basis of available water pressure and volume and physical location/orientation.
4. P.V.C.: P.V.C shall denote the abbreviation for polyvinyl Chloride (schedule 40) material used in the manufacture of pipe and fittings as further specified hereinafter.
5. Poly pipe and Poly connectors: A flexible polyethylene pipe and fittings used in swing joints, head and pipe connectors and emitter systems.
6. Owner: That entity which holds title or control to the premises on which the work is performed.
7. Landscape Architect: This person or firm is the responsible representative of the owner who produces the landscape and/or irrigation plans and specifications.
8. Contractor: In reference to these specifications, the “Contractor” shall mean the irrigation contractor bidding on and/or being awarded the contract for the work stipulated. Said contractor shall be duly licensed and insured as an irrigation supplier/contractor to perform necessary water supply and distribution function in the state, county and municipality where the work is to be executed.
9. Project: the project as referenced herein shall be the tract of real property where the irrigation system is to be installed.
10. Contract Documents: For the purpose of bid submission, contract agreement and execution of the work, the contact documents shall be binding upon all parties and shall include but not be limited to applicable plans, details, schedules, specifications and bidder instructions.
11. Equivalency: relevant to manufacturer product lines specified herein, equivalents shall be of like type, manufacture, design, material, operation and performance. They shall be approved by the Landscape Architect.
12. The Plans: Design drawings and specifications provided by the Landscape Architect. In the event of conflict between the plans and the written specifications, the plans shall prevail.

PART 2 MATERIALS

2.01 PRODUCTS

A. All material shall be of new stock and best grade of its kind. It shall be as specified unless otherwise specifically approved by the Landscape Architect. Materials not named shall be subject to approval or rejection by the Landscape Architect. In all cases, work-

manship and material shall conform to the local plumbing code having jurisdiction. Materials shall be installed as recommended by the Manufacturer.

B. Available Manufacturers:

1. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include the following:
   a. Rain Bird
   b. Hunter Industries
   c. Netafim
   d. Toro

2. Products the contractor wishes to substitute as an “Approved Equivalent” must be submitted to the Landscape Architect, in writing, a minimum of ten (10) days prior to the bid date. The Landscape Architect will provide either an approval or rejection of all products submitted in this fashion.

D. Plastic Pipe shall be rigid, high impact, Type 1, un-plasticized polyvinyl chloride. The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, deleterious wrinkles or dents and shall conform to the following dimensions and physical properties:

1. All plastic pipe shall be continuously and permanently marked with manufacturer’s name, kind of pipe, material size, IPS, NSF approval, schedule and type.
2. Plastic pipe shall be manufactured by Lasco, Celanese, Pacific Western, Colonial, Universal or as by specified emitters, at appropriate P.S.I. ratings.
3.Polyethylene pipe to be used for swing joints (for spray heads only), connectors or emitters at appropriate P.S.I. ratings.

E. Pipe fittings:

1. Plastic pipe fittings to be installed shall be medium weight injection molded for virgin Type 2 high impact un-plasticized rigid polyvinyl chloride (P.V.C.) molding compound. All plastic slip couplings shall be extruded fittings from same material as specified for plastic piping herein, unless otherwise approved by the Landscape Architect. Plastic pipe cement shall be recommended by pipe manufacturer.
2. Galvanized pipe and fittings: Where indicated, or required by code, use galvanized steel pipe ASA Schedule 40 mild steel screwed pipe. Fittings shall be medium galvanized screwed, beaded malleable iron. Galvanized couplings may be a merchant coupling.
3. Under Pavement Lines: All piping under concrete and asphalt vehicle pavement, curbs, unpaved areas subject to other than normal loads shall be rigid P.V.C. Schedule 40.

G. Sprinkler Risers and Connectors:

1. Shrub risers are to be Schedule 40.
2. Pop-up spray connectors (from tee to head base) are to be ½ “ Flexible PVC
3. Pop-up rotor connectors (from tee to head base) are to be rigid 3/4” Lasco Swivel Joints

H. Valves:

1. Manufacturer’s standard, of type and size required, and as herein further specified, clearly identified with purple markings or labels for Reclaimed Waste Water.
2. Automatic Circuit Valves: Globe or angle configuration valves operated by low power solenoid, normally closed, manual flow adjustment. All electric/hydraulic control valves shall be fully compatible with the automatic controller with respect to the type of control, voltage, amperage or pressure specifications and “normal” sequence positioning.
3. Quick Coupling Valves (if specified) : Shall have brass two-piece body designed for working pressure of 150 P.S.I. operable with a quick coupler. Key size and type shall be as shown on the plans or presented in the equipment schedule. Cover to be clearly identified by purple markings for Reclaimed Waste Water.

I. Sprinkler Heads:

1. Manufacturer's standard unit designed to provide uniform coverage over entire area of spray shown on drawings at available water pressure. Top of head to be clearly identified with purple markings for Reclaimed Waste Water.
2. Pop-up Spray: Fixed or adjustable pattern, with screw-type flow adjustment and stainless steel retraction spring.
3. Pop-up Rotary Sprays: Gear-driven, full circle and part circle.

J. Valve Boxes:

1. All gate and control valves shall be set in valve boxes with snap lock covers flush with finished grade. Valve boxes shall be "Carson" or "Ametek".

K. Automatic Control System:

1. The automatic controllers shall be as specified on the Plans or shall be of a capacity as required to efficiently operate the zones throughout the building and parking lot sites. The 120 volt electrical power to the automatic controller's location is to be furnished by the Owner (See Facilities Manager for exact controller location). Irrigation Sub-Contractor shall make all connections in the low-voltage system between the automatic controller and the valves.
2. Schedule the controller time clocks to operate the system control as nearly as possible between the hours of 11:00 P.M. and 7:00 A. M., and on the days required by local watering guidelines for deep well water source systems.

L. Sleeves and Conduits:

1. All pipe and wiring under paving shall be placed in separate Schedule 40 P.V.C. sleeves and conduit respectively for the full pavement covered length. Sleeves and conduit are to be installed as shown on the Irrigation Plan or determined in the field. Sleeves and conduit shall be of adequate diameter to accommodate the pipe (s) / wire (s) with sufficient free play to allow removal and reinstallation without binding.

M. Control Wiring:

1. Connections between the automatic controllers and the electric valves shall be made with Hunter Industries approved jacketed two-wire. All connections will be Hunter approved DBRY-6 sealed wire connectors.

N. Valves:

1. General: Manufacturer's standard, of type and size required. And/or as specified on the Plans.
2. Gate Valves shall conform to federal specifications WWV 54, Type 1, Class A, with all brass or bronze body, non-rising stem," Apollo by Lasco"
3. Valves shall be clearly identified with purple markings and labels when reclaimed water is used.
4. Automatic Circuit Valves: Globe or Angle configuration valves operated by low-power solenoid, normally closed, manual flow adjustment. All electric/hydraulic control valves shall be fully compatible with the automatic controller with respect to the type of control voltage, amperage or pressure specifications and "Normal" sequence positioning.
5. Quick Coupling Valves: When specified, shall have a brass two-piece body designed for working pressure of 150 P.S.I. operable with a quick coupler. Key size and type shall be as shown on the plans or presented in the equipment schedule.
6. Other Valves: shall be as stated on the plan.

O. Filters:

1. A Vu-Flow 60 mesh filter is required on all emitter systems. One filter will be required for each source of supply. Filters shall be located underground in an appropriately-sized meter box.

P. Backflow Prevention: (if applicable)

1. Backflow prevention shall be approved by the governing body.

Q. Emitter Pipe:

1. Emitter pipe shall be manufactured by one of the aforementioned suppliers for the express purpose of subsurface irrigation.

2. Pipe shall have prefabricated irrigation orifices placed 12 inches on center.
3. Emitter pipe, if different than those stated herein, must be approved in writing by the Landscape Architect.

PART 3EXECUTION

3.01 SYSTEM DESIGN

A. General:

1. The Contractor shall provide any additional irrigation design data required to complete the Contract Documents. All Contractor submitted design data must provide 100% coverage to all planting and sodded areas to be irrigated as shown on the plans.

B. Design Liability:

1. All irrigation design data provided by the contractor shall be the full liability of the contractor. All such design data shall be consistent with manufacturer's materials and installation methods, code compliance, coverage, application, distribution and operation and the provided plans and technical specifications.

C. design Pressure:

1. Design pressures should be as recommended by the pipe and fitting manufacturer type of pipe selected, or as indicated on drawings.

D. Emitter Pipe Locations:

1. If design data is required, the Contractor is to provide final layout plans of the emitter system specified to reflect the zone and valve locations, and specified coverage.
2. The application rate shall not exceed the intake rate of the soil, and as recommended by the manufacturer.
3. The system shall provide the capability of accomplishing complete watering of the entire areas, for the particular combination of soil type and vegetation being irrigated, within a period of time no greater than that currently being recommended by recognized authorities.
4. Friction losses for pipe will be determined by the Hazen-Williams Formula. The retardance coefficient for P.V.C. pipe shall be 150 and for galvanized pipe 100. "C" factors for other products shall be determined from Marks Mechanical Engineers Handbook or other comparable friction loss tables. Maximum water velocity shall not exceed 5 feet per second in any part of the system.

3.02 INSTALLATION

A. Comply with all requirements of the uniform plumbing code.

B. Layout

1. The locations of heads are approximate. Make minor adjustments as necessary to avoid plantings and other obstructions and to obtain coverage. Pipe may be shown in building, concrete, and/or asphalt areas for clarity only. Locate all pipe in planting areas where appropriate.
2. Emitter lines shall be installed as shown on the plans.

C. Excavation/Trenching

1. Trenches shall be dug straight. Trench bottoms shall be true gradient providing support to pipe through its entire length and shall be free from rocks, clods, de-

bris and sharp edged objects. The minimum depth of lines measured to top of pipe, unless otherwise indicated on plans, shall be:
a. Main lines and quick coupler lines shall be 24”.
b. Lateral sprinkler lines shall be 12”
c. Non-pressure rotor head lines shall be 12”.
d. Top of Emitter lines shall be at grade
e. Provide minimum cover of 24” for all control wiring.
2. Where required or indicated on the plans existing sod shall be removed where trenches are to be dug, and shall be protected from drying and replaced within 48 hours. Sod shall be cut in such a manner that a minimum of 2” of soil remains on the roots. The soil should be moist, but not wet, to prevent excessive loss due to crumbling. This is Irrigation Sub-Contractor shall have all the responsibilities to maintain sodding and grass, trees, shrubs and plants. As required by Section 02900. This Irrigation Sub-Contractor may, at his option contract with the Landscape, sodding and grass Sub-Contractor to handle this responsibility.
3. Back-fill shall not be placed until the installed irrigation system has been thoroughly inspected and tested by the Contractor (the Landscape Architect may request an inspection by his own personnel prior to back-filling of trenches). Back-fill material shall be approved soil, free from large rocks, debris, or sharp objects. In general, the material removed from evacuation may be used. Excavated rocky material shall be removed from the site and suitable fill material obtained for back-fill. Back-filling shall be done when pipe is not in an expanded or contracted condition due to temperature extremes. Cooling of the pipe can be accomplished by operation of the system for a short time before back-fill, or by back-filling in the early part of the morning before the heat of the day. Long runs of P.V.C. pipe shall be “snaked” in the trench to allow for contraction. Back-fill shall follow excavation with the least possible delay. Open trenches shall be adequately protected to cause the least possible hazard to and interference with people and animals. Back-fill shall be compacted in compliance with Earthwork Section. The operation shall be repeated until finished grade of back-filled trenches matches that of adjacent soil.

D. Water Connection:

1. Connect irrigation system to existing source on site. Connection shall include but may not be limited to the installation of appropriate gate valves, shut-off valves, and concrete meter box as required. Coordinate time of connection with affected persons in order to minimize irrigation downtime. Required modifications and/or relocations of equipment associated with the existing well shall be included in the irrigation work.
2. Municipal and County regulations must be adhered to during this and all other portions of work in this section.

E. Circuit Valves:

1. Provide union on downstream side
2. Adjust automatic control valves to provide flow rate of rated operating pressure required for each sprinkler circuit.
3. Wherever possible, locate valves in plant bed areas for best concealment and accessibility.
4. Valves are to be installed in “Carson” valve boxes, large enough to accommodate maintenance and operation of valves. Provide a ½” diameter river gravel sump 3” thick at bottom of valve pit.

F. Piping

1. Pipe shall be handled and stored in a manner to prevent damage. The plastic pipe and fittings shall be stored under cover, and shall be transported in a vehicle with a bed long enough to allow the length of the pipe to lay flat so as not to be

subject to undue bending or concentrated external load at any point. Any plastic pipe that has been dented or damaged shall not be used unless damage has been cut and pipe is rejoined with a coupling.
2. Clean interior of pipe thoroughly and remove all dirt or foreign matter before lowering pipe into trench. Keep pipe clean during operations by plugs or other approved methods. The ends of all threated shall be reamed out full size with a long taper reamer so as to be partially bell-mouthed and perfectly smooth. All water lines shall be thoroughly flushed out before heads are installed.
3. Lay pipe on solid sub-base, uniformly sloped without humps or depressions.
4. Install P.V.C. pipe in dry weather when temperature is above 40 degrees Fahrenheit in strict accordance with manufacturer's instructions. Allow joints to cure at least 24 hours at temperatures above 40 degrees Fahrenheit before testing, unless otherwise recommended by manufacturer.
5. Welded joints shall be given at least 15 minutes set-up curing time before moving or handling. Pipe shall be partially center loaded to prevent arching and whipping under pressure. Plastic pipe shall be cut with a hand saw, hacksaw or other tool approved for such use in a manner so as to insure square ends. Burrs at cut ends shall be removed prior to installation so that a smooth unobstructed flow will be obtained. All plastic-to -plastic joints shall be solvent-weld joints.
Only the solvent recommended by the pipe manufacturer shall be used. The solvent-weld joints shall be made in the following matter:
a. Thoroughly clean the mating pipe and fitting with a clean dry cloth.
b. Apply primer to all connections prior to applying solvent. Use only compatible primer following manufacturer's specifications.
c. Apply a uniform coat of solvent to outside of the pipe with a non-synthetic bristle brush. Apply solvent to fitting in a similar matter.
d. Reapply a light coat of solvent to pipe and quickly insert it into the fitting. Give the pipe or fitting a quarter turn to insure even distribution of the solvent and make sure the pipe is inserted to the full depth of the fitting socket.
e. Hold in position for 15 seconds. Wipe off excess solvent that appears at the outer shoulder of the fittings.
f. Care shall be taken so as not to use an excess amount of solvent thereby causing a burr or obstruction to form on the inside of the pipe. The joints shall be allowed to set at least 24 hours before pressure is applied to the system.

E. Pipe jointing, in general, shall be performed by competent tradesmen specially trained in the type of work required and using tools and equipment recommended by the manufacturers of the pipe, fittings or equipment.

F. Galvanized Steel Pipe and Fittings: Threads shall be sound, clean cut, and well fitting. Threated joints shall be made up with the best quality pure joint compound or lead paste, carefully and smoothly placed on the male threads only, remade with new material. Use of thread cement or caulking to make joints tight will not be permitted. All cut ends shall be remade to full bore before assembly.

G. Plastic to Steel Connections: Male thread plastic to female thread steel shall be used. The same shall apply to plastic and brass or other metal. In no case shall metal be screwed into a plastic fitting. A non-hardening pipe dope such as "Permatex No. 2" or equal shall be used on threated plastic to metal joints, and light wrench pressure should be used.

H. Hose bibs:

1. If specified, shall be installed upstream of the electric valve in the same meter box. (Hose bibs may be used with a pressure gauge to check pressure.)

J. Sprinkler Heads and Adjustment:

1. Sprinkler heads shall be installed in a plumb position at intervals not to exceed the maximum spacing specified by the manufacturer for project conditions, or as indicated on the drawings.
2. Heads in turf areas shall be installed 6”away from the edge of the curb or walk, and shall be set 3/8” below the edge of the curb or walk. All heads shall be installed on flexible connectors or swing joints and shall allow for vertical adjustment of heads, 6” pop-up spray heads or 4” pop-up rotors (where appropriate) shall be used in turf areas.
3. All groundcover areas, including mass plantings of dwarf shrubs not exceeding 22”, shall be irrigated with 12” pop up spray heads and extenders.
4. Shrub risers shall only be installed in hedges or mass plantings of large shrubs and are not to extend more than 3” above the installed height of the shrub. If risers are used in hedges abutting parking areas, they must be placed a minimum of 30” away from back of curb and imbedded in hedge so as not to be seen or damaged by vehicle overhang. All risers and other above-ground piping and fixtures shall be painted with a permanent flat black enamel paint. Stake all risers over 2’ with 1/4” reinforcing rod fastened securely to riser.
5. Provide swings joints on all pop-ups and rotors. Flexible poly pipe may be used as swing joints for spray heads only. All rotor heads shall be installed on appropriate sized rigid Schedule 40 PVC swing joints.
6. Pop-up heads adjacent to vehicle pavement that is not curbed shall be installed with concrete donut protectors set flush with the top of the heads. Heads installed adjacent to pedestrian walk or curbs shall be installed 6” away from the curb or walk. Where adjacent to buildings, fences or similar structures, heads shall be installed 12” away from the structure.
7. Install no multiple assemblies on plastic lines. Provide each assembly with its own outlet.

3.03 SYSTEM CHECK

A. In no event shall the Contractor cover up or otherwise remove from view any work under this contract that has not been thoroughly inspected and tested, **if required**. If inspections are required the Owner and/or Landscape Architect shall be present at time of inspection and testing. Any work covered prior to being inspected shall be opened to view by the Contractor at his expense. Notify the Owner and Landscape Architect when testing will be conducted.

B. Pressure Testing: All pressure lines shall be tested prior to back-fill of joints. As soon as lines are connected, flushed out, and valves are attached, cap all outlets and hydrostatically test at available pressure for a continuous 4 hour period, at the end of which the lines and joints will shall be inspected. If leaks develop, the joint or joints shall be replaced, and the test repeated until all leaks are repaired. Any covered pipe, found to leak, shall be excavated and repaired at the Contractor’s expense.

C. Operational Testing: The entire installation shall be placed in operation by the Contractor and tested in the presence of the Owner or his representative for proper functioning as a whole. Location and arc of heads shall be adjusted if required to eliminate any dry spots, over-water or spillage on adjacent areas and to prevent over-spray onto walks, roadways and buildings as much as possible.

3.04 AS BUILT RECORDS AND ADDITIONAL EQUIPMENT

A. Furnish record drawings of “as built” conditions as follows:

1. Location of water supply
2. Tie-in and Owner furnished electrical service and disconnects.

3. Location of valve controllers and other control equipment.
4. Routing and sizing of sprinkler main line.
5. Location and type of sprinkler heads.
6. Location and size of gate and zone control valves.
7. Location of wire-splice boxes.
8. Routing of zone control valve electrical wiring.
9. The location of all “as built” conditions different from the original drawing shall be to scale from permanent points of reference. Exact location of main line, control cables, and control valves shall be shown.

B. The Contractor shall provide as part of this contract, two sets of sprinkler wrenches for adjusting, cleaning or disassembling each type of sprinkler. Two each of any special tools required for any other equipment shall also be furnished.

C. Two (2) service manuals for all equipment used shall be furnished to the Owner. Manuals may be loose-leaf and should show shop drawings or exploded views of equipment and catalog number. Operation instructions for all equipment shall be furnished.

3.05 WARRANTY

A. The Irrigation Sub-Contractor and Contractor shall warranty all Materials employed in the irrigation installation, are installed as specified and is in accordance with best trade practices. The Warranty shall also state there are no unauthorized substitutions of materials.
B. The Irrigation Sub-Contractor and Contractor shall warranty the work for a period of one (1) year.
C. The Contractor shall be responsible to replace all plant materials which have declined in health or have died due to a defective irrigation system. The contractor shall replace affected plantings with plants of same variety and value within ten days of notice.
D. Corrections: should any trouble develop within the specified warranty period which in the opinion of the owner is due to inferior or faulty materials and/or workmanship, the trouble shall be corrected without delay by the Contractor, to the satisfaction od and at no expense to the Owner
E. Liability: Any and all damage to rain water drains, water supply lines, shall be repaired and made good by the Contractor at no extra cost to the Owner. It is the responsibility of the Contractor to be aware of the location of all utilities or other permanent or non-permanent installations from any damage whatsoever.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 32 91 15
SOIL PREPARATION

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Drawings and general provisions of the Contract apply to this Section.

B. Examine all Drawings and all Sections of the Specifications for requirements and provisions affecting the Work of this Section.

C. Landscape practices for this project shall conform to all landscape and land development codes of City of Sanibel, FL; Lee County, FL; State of Florida; and United States Federal regulations.

D. Excavation and disturbance of soils on site shall be limited to the immediate area of work.

E. Landscape contractor shall hold City of Sanibel Vegetation License.

1.2 DESCRIPTION OF WORK

A. The work of this Section consists of providing all equipment and materials and doing all work necessary to supply and place planting soils as indicated on the Contract Documents and as specified. Supplying and placement of planting soils shall include, but not be limited to:

1. Sampling and testing of planting soil components, including existing topsoil, loam borrow, sand and compost.

2. Sampling and testing of blended planting soil mixes.

3. Supplying, placing, spreading and grading of planting soil, including:
   a. Plant Bed Soil (for Trees, Shrubs and Ground Covers)
   b. b. High Use Lawn Planting Soil

4. Providing all other sampling, testing, supplying, placing, spreading and grading of planting soils as required by this Section.

B. Landscape specifications are designed to supplement Site Development and Site Drainage plans, by others. Sub-surface grading and drainage as specified in site development plan set by others. Finish grading and soil amendments are dependent on proper installation of sub-surface grading and drainage. Landscape contractor assumes finish grade soil amendments and topdressing per landscape plans.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surfaces

B. Subgrade: Surface or elevation of subgrade soil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

C. Topsoil: Soil that is present at the top layer of the existing soil profile at the Project site. This shall be considered the “Base Loam 1” component of Planting Soil mixes.

D. Sand: Clean Florida D.O.T. SAND

E. Compost (Organic Amendment Material): a stable, humus-like material produced from the aerobic decomposition and curing of leaf yard waste, composted for a minimum of one year (12 months), free of debris, stones larger than 1/2", larger branches and roots and wood chips over 1" in length or diameter. The compost shall be a dark brown to black color and be capable of supporting plant growth with appropriate management practices in conjunction with addition of fertilizer and other amendments as applicable, with no visible free water or dust, with no unpleasant odor.

F. Planting Soil: Unless otherwise indicated throughout this Section, the term “Planting Soil” shall apply to on-site blended planting soil, as indicated.

G. Blended Planting Soil: To the extent available, existing on-site, in-place topsoil; and/or loam borrow; that is modified on-site with planting soil components and soil amendments to meet the specific Planting Soil mix requirements specified herein.
   1. LAWN AND PLANTING SOILS: The lawn and planting soils shall consist of a blend of natural topsoil, uniform sand, and compost/organic material. The quality of the blend depends on the quality of the original components. The Contractor shall be responsible for locating and obtaining approval of sources of natural topsoil, uniform sand, and compost/organic material that meet the Specification requirements. The Contractor shall then be responsible for mixing the components. Approximate mixing ratios are provided, but may require adjustment, depending on the final materials and with the approval of the Landscape Architect and testing laboratory, in order to meet Specification requirements for each blend.
   2. Base Components
      a. 50% Clean D.O.T. Sand
      b. 50% Approved Compost

1.4 QUALITY ASSURANCE

A. Soil Analysis.
   1. Test existing soils for pH, organic matter, salts, magnesium, calcium, phosphorus, and potash. Samples shall be taken from various locations in each planting area. Each area sampled shall be collected as follows; clean debris from top layer, extract sample to six (6) inches deep, collect three such samples randomly per area, place all three (3) samples in one container, mix thoroughly, take one third (1/3) of the soil and package for sample, discard the rest, this is the sample to be sent for analysis. Submit all samples to an independent testing laboratory for analysis. Laboratory selection is to be approved by the owner’s representative. Request recommendations based on all information provided. Reports from the Laboratory will identify deficiencies and be the basis for the Contractor's recommendations to correct the deficiencies and to adjust pH to comply with the specifications. Tests shall be repeated to ensure compliance with the recommendations and specifications. Submittal of the Contractor's fertilizer program shall be based upon the laboratory recommendations and is required before acceptance of the project work for payment. Submit copies of all test results to owner’s representative for review.

B. Work will be subject to inspection at all times by the Owner. The Owner reserves the right to engage an independent testing laboratory to analyze and test materials used in the construction of the work. Where directed by the Owner, the testing laboratory will make material analyses and will report to the Owner whether materials conform to the requirements of this specification.

1. Cost of tests and material analyses made by the testing laboratory will be borne by the Owner when they indicate compliance with the specification, and by the Contractor when they indicate non-compliance. 2. Testing equipment will be provided by and tests performed by the testing laboratory.

C. Samples of individual components of planting soil mixes shall be submitted by the Contractor for testing and analysis to UMass Soil and Plant Tissue Testing La Include verification testing of on-site stripped and stockpiled topsoil. Comply with specific materials requirements specified.

D. Owner may request additional testing by Contractor for confirmation of mix quality and/or soil mix amendments at any time until final acceptance.

1.5 TESTING & SUBMITTALS

A. The project submittals list will be generated by the landscape architect and must be completed by the contractor and approved by the landscape architect prior to project commencement.

B. All project submittals must be completed and compiled in an easily reproducible form. All submittal sheets must legible or will be refused. Submittal sheets that do not clearly identify the products of materials selected will be refused.

C. Products installed on the project site that are not consistent with the project submittals will be removed and replaced with the products identified in the project submittal package at the contractor's expense.

D. Samples:

E. Soil Test
1. Prior to ordering soil mix components, submit 1 gallon samples to Testing Laboratory for approval.
2. Submittals of Planting Soil Base Components: a. Base Loam b. Compost c. Sand

F. Soil Test Results
1. Submit for review

1.6 EXAMINATION OF CONDITIONS

A. All areas of the existing site where topsoil is to be sampled for testing shall be inspected by the Contractor before starting work and any issues that might inhibit or prevent the sampling operation shall be reported to the Owner prior to beginning this work.

B. The Contractor and any sub-Contractor responsible for the execution of the Work of this Section shall review and confirm in writing that the subgrade soil elevations have been brought to the proper subgrade elevations prior to proceeding with the spreading of planting soil.

C. Carefully review the requirements of this Section to understand the requirements of percolation testing, compaction, slope and absence of debris of the subgrade prior to spreading planting soil.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Material shall not be handled, hauled, placed, spread or compacted when it is wet as after a heavy rainfall. Soil shall be handled only when the moisture content is less than at field capacity. Testing Laboratory and the Owner shall be consulted to determine if the soil is too wet to handle.

B. Store and handle packaged materials in strict compliance with manufacturer's instructions and recommendations. Protect all materials from weather, damage, injury and theft.

C. Sequence deliveries to avoid delay. Deliver materials only after preparations for placement of planting soil have been completed.

D. Prohibit vehicular and pedestrian traffic on or around stockpiled planting soil.

E. Protection of Planting Soil on-site: All planting soil delivered or stockpiled on the site shall be protected from erosion at all times. Materials shall be spread immediately. Otherwise, materials that sit on site for more than 24 hours shall be covered with tarpaulin or other soil erosion system acceptable to the Owner and surrounded by silt fence.

PART 2 - PRODUCTS

2.1 PLANTING SOIL COMPONENTS

A. Topsoil: Topsoil shall be natural, fertile, agricultural soil capable of sustaining vigorous plant growth. It shall be free of uniform composition throughout with admixture of subsoil. It shall be free of stones, lumps, live plants and roots, sticks clay, silts and other extraneous matter. Topsoil shall not be extremely acidic or alkaline, nor contain toxic substances which may be harmful to plant growth. The pH shall be corrected prior to delivery in the range of 5.5 - 7.0. If necessary, after placement the contractor shall apply appropriate approved soil additives adjusting soil pH to ensure a pH range between 5.5-7.0.

B. Sand: Clean F.D.O.T. Sand

C. Compost: Compost shall be sterilized to make free of all viable nut grass and other undesirable weeds. Compost mix shall be free of deleterious materials that would be harmful to plant growth, shall be free of nematodes, shall consistent or like quality and shall have a pH value between 5.5 and 7.0 (as determined in accordance with ASTM E70).

2.2 PLANTING SOIL MIXES - GENERAL

A. Topsoil shall be natural, fertile, agricultural soil capable of sustaining vigorous plant growth. It shall be free of uniform composition throughout with admixture of subsoil. It shall be free of stones, lumps, live plants and roots, sticks clay, silts and other extraneous matter. Spread 1" topsoil mixture to minimum depth of 3 inches throughout all areas. Removal all rocks and other objects in topsoil layer over 1 inch in diameter.

B. Finish all prepared topsoil areas to be smooth, even surface ensuring a minimum of 3% positive drainage away from structures and eliminate any low areas which may collect water.

C. TREE, SHRUB, GROUNDCOVER PLANTING BED & SOD SOIL MIX
   a. 50% Clean D.O.T. Sand

b. 50% Approved Compost

2.3 WATER

1. Water – municipal source. Refer to Irrigation specifications.

PART 3 - EXECUTION

3.1 PREINSTALLATION EXAMINATION AND PREPARATION

A. Tree Protection – refer to vegetation protection detail on landscape plans.

B. Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.

C. Pre-Installation Examination Required: The Contractor shall examine previous work, related work, and conditions under which this work is to be performed and shall notify Owner in writing of all deficiencies and conditions detrimental to the proper completion of this work. Beginning work means Contractor accepts substrates, previous work, and conditions. The Contractor shall not place any planting soil until all work in adjacent areas is complete and approved by the Owner.

D. Examination of Subgrade: The subgrade shall be examined by the Contractor prior to the start of soil placement and planting. Any deficiencies shall be noted and related to the Landscape Architect in writing prior to acceptance of the subgrade by the Landscape Contractor. Deficiencies include, but shall not be limited to the following:

1. Prepared subgrade must infiltrate water at the rate of at least two inches per hour. 2. Construction debris present within the planting areas. 3. The subgrade is at incorrect depths for installing the designed soil profile and drainage layer. 4. Incomplete irrigation and/or subsurface drainage installation. 5. 5.Incomplete lighting and exterior electrical installation. 6. 6.Conflict with underground utilities. 7. 7.Subgrade contaminated with oils, compressible material, silt or clay

E. Do not proceed with Subgrade Preparations or placement of Lawn Soil, until all utility work in the area has been installed.

1. The Contractor shall identify the locations of underground utilities prior to proceeding with soil work and shall protect all utilities from damage

3.2 EXCAVATION AND REMOVALS

A. Portions of the project site may require removal and replacement of existing soils to accommodate the new soil profile. Other portions of the project site will require in situ decompaction and amendment of soils.

B. Some of the stripped topsoil shall be re-used on the project site, as determined by soil testing, and after approval by the Owner and Testing Laboratory.

C. No off-site removal or transport of soils without written permission from Owner.

3.3 SUBGRADE PREPARATION, INSPECTION AND PERCOLATION TESTING

A. After subgrade levels have been reached, the Architect or Soil Scientist shall observe decompaction and preparation of the subgrade according to this Section and inspect soil conditions to evaluate subsurface drainage conditions.

B. Coordinate the following scarification work to eliminate subgrade compaction and improve drainage conditions when located in lawn areas outside of Critical Root Zones.
   1. Heavy Site Subgrade Compaction Mitigation:
      a. Heavily compacted subgrade areas such as, but not limited to, temporary parking areas, material stockpile areas, temporary roadways, construction areas and areas around structures and other similar areas.
      b. Prior to establishing the final subgrade, these areas shall be dug up or ripped to a depth of (12) inches to break up the soil hard pan, then re-compacted with two passes of the tracks of a wide track bulldozer size D-6 or smaller, or other approved equipment. Vibratory compaction of subgrade in planted areas is prohibited.

C. The contractor shall bear all costs of testing of soils, amendments, etc., associated with the work and included in the specifications. Prior to commencement of the landscape planting work, the contractor shall provide complete soil tests for the installation area
   1. Apply approved herbicide equal according to manufacturer's rate and specification within limits of all areas to be planted. Protect existing plants to remain from over spray or spray within root zone. Contactor to ensure total weed eradication.
   2. Before replacing topsoil, rake subsoil surface clear of stones (1-inch diameter and larger), debris rubbish, deleterious materials and all remaining construction debris to t depth of 6". Contaminated soils shall be removed and replaced to their full depths and extents.
   3. Establish or reestablish rough grades ensuring positive flow and aesthetic land-form shapes shown in the grading plans. Scarify subsoil to a depth of 3 inches once rough grade has been established.
   4. Contractor to apply an approved pre-emergent herbicide in accordance with manufacturer's rate and specifications.

D. The Contractor shall perform percolation and compaction tests within each planting area to ensure that all plant material has adequate drainage to survive and produce normal, viable growth through its natural life span. Test for drainage by completely filling with water to finish grade a 12" round test hole. The test hole shall be dug to a depth of 12" deep from finished grade. Water must percolate at a rate of not less than 2" per hour after the sub-soil becomes saturated. Provide owner's representative with test results and written recommendations to improve percolation/compaction. After correcting any disclosed percolation/compaction problems, the testing shall be repeated to verify success.

E. Planting and sod areas shall be prepared according to this document and with adjustments required as a result of the compaction/percolation and soil testing. All planting areas containing inferior or compacted soil not meeting requirements for planting soil backfill set forth herein must be scraped clean to depth of 2" below finished grade in areas where landscape beds and St. Augustine Floratam sod are proposed.

F. If necessary, the planting areas for any trees or palms shall be prepared by excavation of limerock or caprock existing just below grade to a depth of 3 feet. Volume of rock removed shall be calculated by contractor as per site excavation conditions.
   1. In areas where limerock exists in parking lot islands and medians, limerock shall be excavated to a depth of 12" under planting areas.
   2. Excavation of limerock at the back of the curb shall be no deeper than 6" for a distance of 12" beyond the back edge of the curb; confirm with project engineer.

G. Fill dirt and planting topsoil shall be calculated by contractor as per site excavation conditions. Fill dirt shall be infilled to a depth of 2 inches below finish grade. Grade in the center of planting beds may be 1-2" higher than finish grade to allow for positive drainage away from landscape beds. Finish grade at the edge of landscape beds shall be equal to grades set forth on engineering plans. The finished grade of the soil shall be 3" below the top of finished hardscape, sidewalks, curbs and paver areas to accommodate the layer of mulch or turf.

3.4 PREPARATION OF TREE PITS

A. After tree planting pits have been excavated to the dimensions shown on the plans, the entire bottom area of the pit shall be loosened to a minimum depth of two feet utilizing the bucket of a backhoe or equivalent equipment. The entire loosened area shall then be compressed firmly with the bucket of the backhoe. The central portion of the pit, beneath the rootball, shall be compressed adequately to support the rootball and prevent settlement.

3.5 PLACEMENT OF PLANTING SOIL IN PLANTING BEDS

A. Planting Bed Medium shall be spread in lifts not greater than six inches and compacted to a density between 82 and 86 percent Standard Proctor Maximum Dry Density. The surface area of each lift, including the subgrade after it has been compressed by a backhoe, shall be scarified by raking prior to placing the next lift.

B. Place and spread planting medium to a depth greater than required such that after settlement, finished grade conforming to the lines, grades and elevations shown on the Drawings. Ensure proper drainage in an uninterrupted pattern free of hollows and pockets.

C. Remove stiff clods, lumps, brush, roots, stumps, litter and other foreign material and stones over one inch in diameter and dispose of legally off site.

D. Planting soil/ organic compost mix to be used in beds shall be utilized at the discretion of the landscape architect to further enhance soil amendments in key landscape beds and to achieve topographic changes to areas of interest.

3.6 PLACEMENT OF PLANTING SOILS IN BAHIA AREAS

A. Place and spread planting soil to a depth required such that after settlement and sod installation that finished grade is achieved that conforms to the grades and elevations as shown on the Drawings. Top of Sod (not top of blade) shall be 1/2" lower than existing walks, drives and paver elevations.

B. Ensure proper drainage in an uninterrupted pattern free of hollows and pockets.

C. Remove stiff clods, lumps, brush, roots, stumps, litter and other foreign material and stones over one inch in diameter and dispose of legally off site.

D. Areas to be stabilized with Bahia sod shall be scraped clean and free of rocks and debris. Bahia sod areas shall receive 1" soil depth tilled into top 3" of soil.

3.7 FINE GRADING

A. Grade Stakes: Sufficient grade stakes shall be set for checking the finished grades. Stakes must be set in the bottom of swales and at the top of slopes. Deviation from indicated elevations that are greater than one-tenth of a foot shall not be permitted. Connect contours and spot elevations with an even slope. Finish grades shall be smooth and continuous with no abrupt changes at the top or bottom of slopes.

B. Unless off-site pre-blended planting soil is used, soil additives shall be spread and thoroughly incorporated into the layer of planting soil by harrowing or other methods reviewed by the Owner.
   1. Contractor shall add soil amendments as recommended by the soil analysis and retest planting soil after amendments are completed.

C. Pre-blended planting soil shall be sampled and tested as specified.

D. Soil Compaction:
   1. During the compaction process, all depressions caused by settlement or rolling shall be filled with additional planting soil and the surface shall be regraded and rolled until presenting a smooth and even finish corresponding to the required grades.
   2. Percolation Tests: Compact each lift sufficiently to reduce settling but not enough to prevent the movement of water and feeder roots through the soil. The planting soil in each lift should feel firm to the foot in all areas and make only slight heel prints. At completion of the planting soil installation, the soil should offer a firm, even resistance when a soil sampling tube is inserted from lift to lift. After the placement of each lift, perform percolation tests to determine if the planting soil has been over compacted. Perform the following percolation test procedure
      a. Dig a hole in the installed planting soil that is a minimum of 4 inches in diameter. Holes in 6-inch lift in turf areas shall be 4 inches deep. Holes in 12-inch lifts in plant beds shall be 8 inches deep. Do not penetrate through the lift being teste b. Fill the hole with water and let it drain completely. Immediately refill the hole with water and measure the rate of fall in the water level. c. In the event that the water drains at a rate less than one inch per hour, till the planting soil to a depth required to break the over compaction. d. Perform a minimum of one soil percolation test per 10,000 square feet area of turf area and 2,500 square feet of tree and shrub planting are
   3. Movement of equipment: Select equipment and otherwise phase the installation of the planting soil to ensure that wheeled equipment does not travel over subgrade or already installed planting soil. Movement of tracked equipment over said soils will be reviewed and considered for approval by the Owner. If it is determined by the Owner that wheeled equipment must travel over already installed soil, provide a written description of sequencing of work that ensures that compacted soil is loosened and un-compacted as the work progresses or place a one-inch thick steel plate over the length and width of any travel way to cover planting soil to protect it from compaction.

E. Disturbance outside of limit of work: Disturbed areas outside the limit of work and outside CRZ shall be graded smooth and spread with a minimum of six (6) inches of planting soil to the finished grade.

F. Stockpiles: Upon written approval by the Owner, Contractor shall remove all excess, unused existing on-site topsoil from the site and dispose of it in a legal manner.

3.8 PROTECTION

A. The Contractor shall protect landscape work and materials from damage due to landscape operations, operations by other Contractors or trespassers. Maintain protection during installation until acceptance. Treat, repair or replace damaged Lawn Soil installation work immediately.

B. Provide all means necessary, including fences, to protect all soil areas from compaction and contamination by trash, dust, debris, and any toxic material harmful to plants or humans after placement. Any area that becomes compacted, shall be de-compacted and tilled to the extent determined by the soil scientist and recompressed to the density ranges specified. Any uneven or settled areas shall be filled, re-graded and re-compacted to meet the requirements of this Specification. Soil that becomes contaminated shall be removed and replaced with specified soil material.

C. Phase the installation of the High Use Lawn Soil such that equipment does not have to travel over already installed soil. Use of haul roads is acceptable provided that the haul road is completely re-worked to meet the requirements of this Specification.

3.9 CLEAN-UP

A. During installation, keep pavements clean and work area in an orderly condition.

B. Keep the site free of trash and debris at all times. Immediately dispose of wrappings or waste materials associated with products necessary for the completion of the work.

C. All trash and debris shall be kept in a central collection container. Do not bury trash and debris in back-fill.

D. Once installation is complete, remove any excess soil from pavements or embedded in fixtures.

3.10 COORDINATION AND EXCESS MATERIALS

A. Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.

B. Excess Planting Soil Mixtures and Materials: Remove the excess planting soil mixture and materials from the site at no additional cost to the Owner unless otherwise requested.

3.11 ACCEPTANCE

A. Confirm that the final grade of planting soil is at the proper finish grade elevations.

END OF SECTION 32 91 15

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 32 93 00
PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. The scope of work includes all labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and installation of planting (also known as "landscaping") complete as shown on the drawings and as specified herein.

B. The scope of work in this section includes, but is not limited to, the following:
1. Locate, purchase, deliver and install all specified plants.
2. Water all specified plants.
3. Mulch, fertilize, stake, and prune all specified plants.
4. Maintenance of all specified plants until the beginning of the warranty period.
5. Plant warranty.
6. Clean up and disposal of all excess and surplus material.
7. Maintenance of all specified plants during the warranty period.

1.2 CONTRACT DOCUMENTS

A. Shall consist of specifications and general conditions and the construction drawings. The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any parts shall be as binding as if called for in all parts.

1.3 RELATED DOCUMENTS AND REFERENCES

A. Related Documents
1. Drawings and general provisions of contract including general and supplementary conditions and Division I specifications apply to work of this section
2. Related Specification Sections
   a. Section - Planting Soil.
   b. Section - Irrigation

B. References: The following specifications and standards of the organizations and documents listed in this paragraph form a part of the specification to the extent required by the references thereto. In the event that the requirements of the following referenced standards and specification conflict with this specification section the requirements of this specification shall prevail. In the event that the requirements of any of the following referenced standards and specifications conflict with each other the more stringent requirement shall prevail or as determined by the Owners Representative.
1. Florida Grades and Standards for Nursery Stock, current edition (Florida Department of Agriculture, Tallahassee FL).
2. ANSI Z60.1 American Standard for Nursery Stock, most current edition.
3. ANSI A 300 – Standard Practices for Tree, Shrub and other Woody Plant Maintenance, most current edition and parts.

1.4 VERIFICATION

1. All scaled dimensions on the drawings are approximate. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions and quantities, and shall immediately inform the Owner's Representative of any discrepancies between the information on the drawings and the actual conditions, refraining from doing any work in said areas until given approval to do so by the Owner's Representative.
2. In the case of a discrepancy in the plant quantities between the plan drawings and the plant call outs, list or plant schedule, the number of plants or square footage of the planting bed actually drawn on the plan drawings shall be deemed correct and prevail.
3. Landscape contractor shall refer to the landscape planting details, plant list, general notes and the planting specifications for complete landscape planting instructions. Notify landscape architect of any and all discrepancies prior to construction or installation.

1.5 PERMITS & REGULATIONS

A. The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Owner's Representative in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work. Landscape contractor shall hold a current vegetation license with the City of Sanibel.

B. The landscape contractor shall obtain all necessary permits to complete work, and shall comply with all local, state and federal regulations.

C. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.

D. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or Owner's Representative shall determine which shall govern.

1.6 SUBMITTALS

A. See contract general conditions for policy and procedure related to submittals.

B. Submit all product submittals 8 weeks prior to installation of plantings.

C. Product data: Submit manufacturer product data and literature describing all products required by this section to the Owner's Representative for approval. Provide submittal eight weeks before the installation of plants.

D. Samples: Submit samples of each product and material where required by the specification to the Owner's Representative for approval. Label samples to indicate product, characteristics, and locations in the work. Samples will be reviewed for appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

E. Close out submittals: Submit to the Owner's Representative for approval.

1. Plant maintenance data and requirements.

1.7 OBSERVATION OF WORK

A. The Owner's Representative may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.

B. The Owner's Representative shall be informed of the progress of the work so the work may be observed at the following key times in the construction process. The Owner's Representative shall be afforded sufficient time to schedule visit to the site. A minimum of 48 hours notice is required for requested site inspections. Failure of the Owner's Representative to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.
   1. SITE CONDITIONS PRIOR TO THE START OF PLANTING: review the soil and drainage conditions.
   2. COMPLETION OF THE PLANT LAYOUT STAKING: Review of the plant layout.
   3. PLANT QUALITY: Review of plant quality at the time of delivery and prior to installation. Review tree quality prior to unloading where possible, but in all cases prior to planting.
   4. COMPLETION OF THE PLANTING: Review the completed planting.

1.8 PRE-CONSTRUCTION CONFERENCE

A. Schedule a pre-construction meeting with the Owner's Representative at least seven (7) days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction and project work schedule.

1.9 QUALITY ASSURANCE

A. Comply with governing codes and regulations.
   1. Code required landscape material, species, quantity, and sizes shall be installed as specified. Any deviation or substitution of required plant material shall be approved by Landscape Architect.
   2. Any change in code required plant material shall be captured in As-Built or Record Drawings.
   3. Landscape contractor shall adhere to current City of Sanibel Land Development Code.

B. Substantial Completion Acceptance - Acceptance of the work prior to the start of the warranty period:
   1. Once the Contractor completes the installation of all items in this section, the Owner's Representative will observe all work for Substantial Completion Acceptance upon written request of the Contractor. The request shall be received at least ten calendar days before the anticipated date of the observation.
   2. Substantial Completion Acceptance by the Owner's Representative shall be for general conformance to specified size, character and quality and not relieve the Contractor of responsibility for full conformance to the contract documents, including correct species.
   3. Any plants that are deemed defective as defined under the provisions below shall not be accepted.
   4. Contractor to replace rejected plant material within one week (5 Business days) of notice.

C. The Owner's Representative will provide the Contractor with written acknowledgment of the date of Substantial Completion Acceptance and the beginning of the warranty period and plant maintenance period (if plant maintenance is included).

D. Contractor's Quality Assurance Responsibilities: The Contractor is solely responsible for quality control of the work.

E. Installer Qualifications: The installer shall be a firm having at least 3 years of successful experience of a scope similar to that required for the work, including commercial and public work of greater than 1 acre on southwest Florida barrier islands. The same firm shall install planting soil (where applicable) and plant material.
   1. The bidders list for work under this section shall be approved by the Owner's Representative.
   2. Installer Field Supervision: When any landscape work is in progress, installer shall maintain, on site, a full-time supervisor who can communicate in English with the Owner's Representative AND holds valid City of Sanibel Vegetation Competency Card.
   3. Installer's field supervisor shall have a minimum of five years experience as a field supervisor installing plants and trees of the quality and scale of the proposed project, and can communicate in English with the Owner's Representative.
   4. The installer's crew shall have a minimum of 3 years experienced in the installation of Planting Soil, Plantings, and Irrigation (where applicable) and interpretation of soil plans, planting plans and irrigation plans.
   5. Submit references of past projects, employee training certifications that support that the Contractors meets all of the above installer qualifications and applicable licensures.

1.10 PLANT WARRANTY

A. Plant Warranty
   1. The Contractor agrees to replace defective work and defective plants. The Owner's Representative shall make the final determination if plants meet these specifications or that plants are defective. Plant warranty shall begin on the date of Substantial Completion Acceptance and continue for the following periods, classed by plant type:
      a. Trees & Palms – 1 Year
      b. Shrubs – 6 Months
      c. Groundcover – 6 Months
      d. Sod – 45 Days
   2. All plants shall be warrantied to meet all the requirements for plant quality at installation in this specification. Defective plants shall be defined as plants not meeting these requirements. The Owner's representative shall make the final determination that plants are defective.
   3. Plants determined to be defective shall be removed immediately upon notification by the Owner's Representative and replaced without cost to the Owner, as soon as weather conditions permit and within the specified planting period.
   4. Any work required by this specification or the Owner's Representative during the progress of the work, to correct plant defects including the removal of roots or branches, or planting plants that have been bare rooted during installation to observe for or correct root defects shall not be considered as grounds to void any conditions of the warranty. In the event that the Contractor decides that such remediation work may compromise the future health of the plant, the plant or plants in question shall be rejected and replaced with plants that do not contain defects that require remediation or correction.
   5. Replacements shall closely match adjacent specimens of the same species. Replacements shall be subject to all requirements stated in this specification. Make all

necessary repairs due to plant replacements. Such repairs shall be done at no extra cost to the Owner.

6. During and by the end of the warranty period, contractor shall remove all tree wrap, ties, and guying unless agreed to by the Owner's Representative to remain in place. Tree stakes shall be removed from all trees by the one year warrantee period. Any trees that do not have sufficient caliper to remain upright, or those requiring additional anchorage in windy locations, shall be staked or remain staked, if required by the Owner's Representative.

B. End of Warranty Final Acceptance - Acceptance of plants at the end of the warranty period.
1. At the end of the warranty period, the Owner's Representative shall observe all warranted work, upon written request of the Contractor. The request shall be received at least ten calendar days before the anticipated date for final observation.
2. End of Warranty Final Acceptance will be given only when all the requirements of the work under this specification and in specification sections Planting Soil and Irrigation have been met.

1.11 SELECTION AND OBSERVATION OF PLANTS

A. The Owner's Representative may review all plants subject to approval of size, health, quality, character, etc. Review or approval of any plant during the process of selection, delivery, installation and establishment period shall not prevent that plant from later rejection in the event that the plant quality changes or previously existing defects become apparent that were not observed.

B. Plant Selection: The Owner's Representative reserves the right to select and observe all plants at the nursery prior to delivery and to reject plants that do not meet specifications as set forth in this specification. If a particular defect or substandard element can be corrected at the nursery, as determined by the Owner's Representative, the agreed upon remedy may be applied by the nursery or the Contractor provided that the correction allows the plant to meet the requirements set forth in this specification. Any work to correct plant defects shall be at the contractor's expense.

C. The Contractor shall bear all cost related to plant corrections.

D. All plants that are rejected shall be immediately removed from the site and acceptable replacement plants provided at no cost to the Owner.

E. Where requested by the Owner's Representative, submit photographs of plants or representative samples of plants. Photographs shall be legible and clearly depict the plant specimen. Each submitted image shall contain a height reference, such as a measuring stick. The approval of plants by the Owner's Representative via photograph does not preclude the Owner's Representative's right to reject material while on site.

1.12 PLANT SUBSTITUTIONS FOR PLANTS NOT AVAILABLE

1. Plant material selections may change based upon availability, on site specific conditions, and are not limited to the plant material listed in the plan schedule. Minimum quantity and quality will be maintained. The landscape architect retains the right to make necessary or required changes as dictated by the above items. No substitutions will be allowed without prior written permission of the landscape architect.

2. Submit all requests for substitutions of plant species, or size to the Owner's Representative, for approval, prior to purchasing the proposed substitution. Request for substitution shall be accompanied with a list of nurseries contacted in the search for the required plant and a record of other attempts to locate the required material. Requests shall also include sources of plants found that may be of a smaller or larger size, or a different shape or habit than specified, or plants of the same genus and species but different cultivar origin, or which may otherwise not meet the requirements of the specifications, but which may be available for substitution.

1.13 SITE CONDITIONS

A. It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to notify the Owner's Representative, in writing, of any circumstances that would negatively impact the health of plantings. Do not proceed with work until unsatisfactory conditions have been corrected.
   1. Should subsurface drainage or soil conditions be encountered which would be detrimental to growth or survival of plant material, the Contractor shall notify the Owner's Representative in writing, stating the conditions and submit a proposal covering cost of corrections. If the Contractor fails to notify the Owner's Representative of such conditions, he/she shall remain responsible for plant material under the warranty clause of the specifications.

B. It is the responsibility of the Contractor to be familiar with the local growing conditions, and if any specified plants will be in conflict with these conditions. Report any potential conflicts, in writing, to the Owner's Representative.

C. The landscape contractor shall re-grade all areas disturbed by plant removal, relocation and or installation work. The landscape contractor shall replace (by Equal size and quality) any and all existing plant material disturbed or damaged during landscape site preparation and installation activities.

D. This specification requires that all Planting Soil and Irrigation (if applicable) work be completed and accepted prior to the installation of any plants.
   1. Planting operations shall not begin until such time that the irrigation system is completely operational for the area(s) to be planted, and the irrigation system for that area has been preliminarily observed and approved by the Owner's Representative.

1.14 PLANTING AROUND UTILITIES

A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.

B. Contractor shall adhere to local municipal planting codes when installing plantings near utilities.

C. The landscape contractor shall be responsible for the locations and protection of all existing utilities shown, all site utilities not shown, and all proposed utilities as per the engineers plans.

D. Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.

E. Notification of Local Utility Locator Service, **"Call Sunshine 811" 1-800-432-4770 toll free, FL Statute 553.851 (1979) requires minimum 2 days notice**. Contractor is responsible for notification of all necessary utility companies 48 hours minimum prior to digging for verification of all underground utilities, irrigation and all other obstructions

Contractor shall coordinate with Owner's representative prior to initiating operations. Should the landscape contractor cause damage to any utilities, necessary repairs shall be made as quickly as practical, at contractor's expense.

1. PLANTS
   a. Except as otherwise specified, size and grade of plant materials shall conform to ANSI Z60.1, latest edition. In no case shall ball size be less than 11 in. in diameter for each inch of caliper.
   b. All trees and shrubs shall be labeled. Labels shall be durable and legible, stating the correct plant name and size in weather-resistant ink or embossed process. Labels shall be securely attached to all plants prior to delivery to the site, being careful not to restrict growth.
   c. Container grown plants shall be well rooted and established in the container in which they are growing. They shall have grown in the container for a sufficient length of time for the root system to hold the planting medium when taken from the container, but not long enough to become root bound. Container grown plants exceeding the sizes indicated in ANSI Z60.1 shall have containers which are not less than 75% of the ball sizes for comparable B&B plant material. Each container plant shall be inspected and root pruned as needed.
   d. Ground Cover and Perennials: Provide ground cover and perennials of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1 .
2. PLANTING SOIL & AMENDMENTS
   a. Planting soil and amendments shall be as specified in Specification Section 329115 - PLANTING SOILS
3. PLANTING ACCESSORIES
   a. Wood Stakes: Straight, sound, rough sawn lumber 2 in. x 2 in., if square, or 2-1/2 in. diameter, if round.. Wire for staking shall be 12 gauge steel.
   b. Strapping: Arbortie, manufactured by DeepRoot Green Infrastructure, LLC, 530 Washington Street, San Francisco, CA 94111 Tel: 800 458 7668 or 415 781 9700; Fax: 800 277 7668 or 415 781 0191, or approved equal.
   c. Wrapping: Arbor Tape, supplied by American Arborist Supplies, 882 S Matlack Street, Unit A, West Chester, PA 19382: Phone: 800-441-8381/610-430-1214; Fax: 610-430-8560; E-mail Address: info@arborist.com, or approved equal.
   d. Edging: extruded aluminum, 6063 alloy, T-6 hardness, maintenance strip edging for straight-line and gentle curve applications in corrugated L-shaped profile.
   e. Root barrier shall be linear type root barrier or root box, capable of blocking tree roots from interfering with adjacent pavement without sacrificing secondary lateral root growth for stability, similar to "Deep Root" tree barrier, manufactured by Deeproot Partners, L.P., Burlingame, CA 94010; "Shawtown Root Barrier Panels" manufactured by NDA Inc., Lindsey, CA 93247; or approved equal.
4. SOD/LAWN
   a. Certified Turfgrass Sod: Superior sod grown from certified, high quality seed of known origin or from plantings of certified grass seedlings or stolons. It shall be inspected by the certification agency of the state in which it is grown to assure

satisfactory genetic identity and purity, overall high quality and freedom from noxious weeds as well as excessive quantities of other crop and weedy plants at time of harvest. All seed or original plant material in mixture must be certified. Turfgrass sod shall meet the published state standards for certification.

1) SOD CHARACTERISTICS
   a) Thickness of Cut: Sod shall be machine cut at a uniform soil thickness of 5/8 in., plus or minus 1/4 in., at the time of cutting. Measurement for thickness shall exclude top growth and thatch.
   b) Strip Size: Individual pieces of sod shall be cut to the supplier's standard width and length. Maximum allowable deviation from standard widths and lengths shall be plus or minus 1/2 in. on width, and plus or minus 5% on length. Broken strips and torn and uneven ends will not be acceptable.
   c) Strength of Sod Strips: Standard size sections of sod shall be strong enough to support their own weight and retain their size and shape if suspended vertically when grasped in the upper 10% of the section.
   d) Moisture Content: Sod shall not be harvested or transplanted when moisture content (excessively dry or wet) may adversely affect its survival.
   e) Time Limitations: Sod shall be harvested, delivered, and transplanted within a 36 hour period unless a suitable preservation method is approved prior to delivery. Sod not transplanted within this period shall be inspected and approved by the Architect prior to its installation.
   f) Thatch: Sod shall be relatively free of thatch. A maximum of 1/2 in. (uncompressed) thatch will be permitted.

b. Submit sod certification for grass species and variety and location of sod source.
c. Sod Producer: Company specializing is sod production and harvesting with minimum five years experience, and certified by the Southern Seed Certification Association.
d. Installer: Company approved by the sod producer.

5. PREPARATION
   a. Decompaction of planting areas and percolation testing shall be conducted in accordance with Specification Section 329115 - PLANTING SOILS.
6. PLANTING MAINTENANCE
   a. Provide maintenance and watering until turnover to OWNER for maintenance and watering. Replace damaged materials and dead or unhealthy plants prior to turnover to OWNER; determination as acceptable to the OWNER.
      1) Maintenance shall consist of pruning, watering, cultivating, weeding, mulching, fertilizing, removal of dead material, repairing and replacing of tree stakes, tightening and repairing of guys, adjusting and replacing of damaged tree wrap material, resetting plants to proper grades and upright position, and furnishing and applying such sprays as are necessary to keep plantings free of insects and disease, and in a healthy growing condition.
      2) One-Year Warranty Period: Provide replacement of plants that fail to thrive for a period of one year after turnover to OWNER; determination as acceptable to the OWNER Project Manager.
7. LAWN MAINTENANCE
   a. Provide maintenance, mowing, watering and weed & pest removal until turnover to OWNER for maintenance and watering. Replace damaged materials and dead or unhealthy lawns prior to turnover to OWNER; determination as acceptable to the OWNER Project Manager.

1) Contractor is responsible for the maintenance of sodded areas during a minimum of 2-month grow in period and up until final acceptance.
2) Contractor is responsible for watering of all sod / bahia areas on site, including areas not covered by an irrigation system.
3) Contractor shall replace damaged materials and dead or unhealthy sod prior to turnover to OWNER; determination as acceptable to the OWNER Project Manager.

PART 2 - PRODUCTS

2.1 PLANTS: GENERAL

A. Standards and measurement: Provide plants of quantity, size, genus, species, and variety or cultivars as shown and scheduled in contract documents.
1. All plans must be healthy, vigorous material, free of pests and diseases. Al plant material shall be in full and strict accordance to Florida No. 1 Grade, according to the “Grades and Standards for Nursery Plants”, published by the Florida Department of Agriculture and Consumer Services. Plant materials in some instances shall exceed No. 1 Grade, in order to meet the minimum requirements of this project. All palms to be sun-grown.
2. All sizes shown for plant material on the plan are to be considered minimum. All plant material must meet or exceed these minimum requirements for both height and spread. Any other requirements for specific shape or effect as noted on the plan shall also be required for acceptance. All trees to be single trunked, unless otherwise noted on plans.
3. All plants including the root ball dimensions or container size to trunk caliper ratio shall conform to ANSI Z60.1 “American Standard for Nursery Stock” latest edition, unless modified by provisions in this specification. When there is a conflict between this specification and ANSI Z60.1, this specification section shall be considered correct.
4. Plants larger than specified may be used if acceptable to the Owner’s Representative. Use of such plants shall not increase the contract price. If larger plants are accepted the root ball size shall be in accordance with ANSI Z-60.1. Larger plants may not be acceptable if the resulting root ball cannot be fit into the required planting space.
5. If a range of size is given, no plant shall be less than the minimum size and not less than 50 percent of the plants shall be as large as the maximum size specified. The measurements specified are the minimum and maximum size acceptable and are the measurements after pruning, where pruning is required.

B. Proper Identification: All trees shall be true to name as ordered or shown on planting plans and shall be labeled individually or in groups by genus, species, variety and cultivar.

C. Compliance: All trees shall comply with federal and state laws and regulations requiring observation for plant disease, pests, and weeds. Observation certificates required by law shall accompany each shipment of plants.

D. Any substitution in size, quantity, and or plant material must be approved by the landscape architect. All plants will be subject to approval by landscape architect before planting can begin.

E. Plant Quality:
1. General: Provide healthy stock, grown in a nursery and reasonably free of die-back, disease, insects, eggs, bores, and larvae. At the time of planting all plants shall have a root system, stem, and branch form that will not restrict normal growth, stability and health for the expected life of the plant.

2. Plants shall be healthy with the color, shape, size and distribution of trunk, stems, branches, buds and leaves normal to the plant type specified. Tree quality above the soil line shall comply with Florida Grades and Standards, tree grade Florida #1 (unless otherwise noted in PLANT SCHEDULE).
   a. Trees shall have one central leader. If the leader was headed, a new leader (with a live terminal bud) at least one-half the diameter of the pruning cut shall be present. 1.) All trees are assumed to have one central leader trees unless a different form is specified in the plant list or drawings or unless approved by landscape architect. All trees must be straight trunked, full headed, and meet all requirement specified, unless otherwise noted.
   b. Any tree with a trunk formed “V” shape crotch will be rejected.
   c. Canopy tress of all sizes are to be selectively pruned after planting to remove inner twig growth, open up the center and expose major branches.
   d. All root-balls shall conform to the size standards set forth in “American Standards for Nursery Stock”. Root bound material shall be rejected.
   e. All graft unions, where applicable, shall be completely closed without visible sign of graft rejection. All grafts shall be visible above the soil line.
   f. Trunk caliper and taper shall be sufficient so that the lower five feet of the trunk remains vertical without a stake. Auxiliary stake may be used to maintain a straight leader in the upper half of the tree.
3. Substitution of field grown trees for trees that are specified as container grown will not be permitted unless otherwise approved by landscape architect.

2.2 SOD

A. Sod shall be the recognized, certified Florida grown Argentine Bahia Turf grass species and variety called for in the drawings or design request.

B. Argentine Bahia sod shall be well matted with roots; shall be of firm tough texture having a compact top growth and heavy root development. Sod shall contain no significant amounts (more than 1%) of weeds or any other objectionable vegetation. It shall not contain any tropical signal grass, common Bermuda, Purple Nutsedge or Torpedo Grass. The soil embedded in the sod shall be free from fungus, vermin and diseases and shall have been mowed at least three times with an approved lawn mower with final mowing not more than 7 days before the sod is cut. The sod shall be taken up in commercial size rectangles measuring 16” x 24”, or in rolls. If rolls are used, all backing material (plastic mesh) must be removed prior to installation. The soil base of the sod shall be of a uniform thickness.

C. Use only sod certified free of fire ants. Before delivering any sod to the project, the Contractor shall furnish to the Owner and the Architect written certification from the supplier that the sod is free of fire ants.

2.3 MULCH

A. Minimum three-inch (3”) thick layer of mulch shall be placed around all new plant material and bare grounded that will not be covered by existing vegetation, sod, gravel, pavement or any other ground cover treatment.

B. Submit supplier’s product specification data sheet and a one gallon sample for approval.

C. Mulch must be hard wood shredded mulch or pine needle. Cypress mulch and colored /dyed mulches are not acceptable.

2.4 TREE STAKING AND GUYING MATERIAL

A. Tree guying to be flat woven polypropylene material, 3/4 inch wide, and 900 lb. break strength. Color to be Green. Product to be ArborTie manufactured by Deep Root Partners, L.P. or approved equal.

B. Stakes shall be lodge pole stakes free of knots and of diameters and lengths appropriate to the size of plant as required to adequately support the plant.

C. Below ground anchorage systems to be constructed of 2 x 2 dimensional untreated wood securing (using 3 inch long screws) horizontal portions to 4 feet long vertical stakes driven straight into the ground outside the root ball.

D. Submit manufacturer's product data for approval.

PART 3 - EXECUTION

3.1 SITE EXAMINATION

A. Examine the surface grades and soil conditions to confirm that the requirements of the Specification Section – Planting Soil - and the soil and drainage modifications indicated on the Planting Soil Plan and Details (if applicable) have been completed. Notify the Owner's Representative in writing of any unsatisfactory conditions.

3.2 DELIVERY, STORAGE & HANDLING

A. Protect materials from deterioration during delivery and storage. Adequately protect plants from drying out, exposure of roots to sun, wind or extremes of heat and cold temperatures. If planting is delayed more than 24 hours after delivery, set plants in a location protected from sun and wind. Provide adequate water to the root ball package during the shipping and storage period.
1. All plant materials must be available for observation prior to planting.
2. Using a soil moisture meter, periodically check the soil moisture in the root balls of all plants to assure that the plants are being adequately watered. Volumetric soil moisture shall be maintained above wilting point and below field capacity for the root ball substrate or soil.

B. Do not deliver more plants to the site than there is space with adequate storage conditions. Provide a suitable remote staging area for plants and other supplies.
1. The Owner's Representative or Contractor shall approve the duration, method and location of storage of plants.

C. Provide protective covering over all plants during transporting. All plant material shall be protected during transport and delivery to job site with shade cloth or within box truck, or other acceptable means of windburn prevention.

D. Contractor shall be responsible for plants meeting specification as noted prior to installation. Contractor shall immediately remove all plant material from the project that does not confirm to specifications.

E. Landscape contractor shall verify all quantities of plant material from the plant legend to the drawings. Quantities from the drawings shall govern unless otherwise noted.

F. Landscape contractor shall refer to vegetation impact plan for preservation and relocation of existing native plants on site. Relocated trees must be located within vegetation receptor area and protected throughout duration of construction activities on site. Relocations shall be tagged with tie tape. Tie tape shall only be removed upon permit approval and final acceptance.

3.3 COORDINATION WITH PROJECT WORK

A. The Contractor shall coordinate with all other work that may impact the completion of the work.

B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

C. Coordinate the relocation of any irrigation lines, heads or the conduits of other utility lines that are in conflict with tree locations. Root balls shall not be altered to fit around lines. Notify the Owner's Representative of any conflicts encountered.

D. The landscape contractor shall coordinate all planting work with irrigation contractor. The landscape contractor shall be responsible for all hand watering as required to supplement irrigation watering and/or rainfall. The landscape contractor shall be responsible for hand watering in all planting areas, regardless of the status of existing or proposed irrigation.

E. All plant material shall be maintained at or above the specified conditions through substantial completion and the end of the establishment period. Decline in condition of plant material during installation, and the maintenance period, shall be grounds for rejection and replacement at contractor's expense.

3.4 LAYOUT AND PLANTING SEQUENCE

A. Relative positions of all plants and trees are subject to approval of the Owner's Representative.

B. The contractor shall field verify all information prior to initiating planting installation. All existing planting shall remain intact and undisturbed unless otherwise noted on the plans.

C. Contractor shall report any and all discrepancies between the construction drawings and field conditions to the Owner's representative.

D. Notify the Owner's Representative, one (1) week prior to layout of all individual tree and shrub locations. Place plants above surface at planting location or place a labeled stake at planting location. Layout bed lines with paint for the Owner's Representative's approval. Secure the Owner's Representative's acceptance before digging and start of planting work.

E. Landscape contractor shall field stake the location of all trees, palms, specimen plant locations, code required plantings and buffers and general plant material prior to beginning installation. Landscape architect shall review and approve staked locations prior to installation. If the bed and shrub layout is not inspected prior to planting the landscape architect reserves the right to relocate the plants.

F. All shrub bedline area definitions to be reviewed in the field with the landscape architect. Unapproved bedlines will be rejected. It is the responsibility of the landscape contractor to remedy all damages and modifications required to correct the areas.

G. The landscape contractor shall field adjust location of plant material as necessary to avoid damage to all existing underground utilities and/or existing above ground elements. All changes required shall be completed at the contractor's expense and shall be coordinated with the owner's representative and the landscape architect.

H. Contractor shall layout and plant all trees, palms, and large shrubs (15 gallon and larger) before laying out and installing other plants.

I. The planting plans are a graphic representation for the aesthetic treatment of the designated site. Actual plant material locations will vary to complement existing vegetation, site conditions, building overhangs and windows, and to provide safety of planting locations.

J. It is understood that plants are not precise objects and that minor adjustments in the layout will be required as the planting plan is constructed. These adjustments may not be apparent until some or all of the plants are installed. Make adjustments as required by the Owner's Representative including relocating previously installed plants.

K. Shrub and ground cover plantings are shown as mass planting beds. Plants shall be placed on a triangular spacing configuration (staggered spacing). Refer to the plant list for plant spacing requirements.

3.5 SOIL PROTECTION DURING PLANT DELIVERY AND INSTALLATION

A. Protect soil from compaction during the delivery of plants to the planting locations, digging of planting holes and installing plants.
   1. Where possible deliver and plant trees that require the use of heavy mechanized equipment prior to final soil preparation and tilling. Where possible, restrict the driving lanes to one area instead of driving over and compacting a large area of soil.
   2. Till to a depth of 6 inches, all soil that has been driven over during the installation of plants.

3.6 INSTALLATION OF PLANTS: GENERAL

A. Observe each plant after delivery and prior to installation for damage of other characteristics that may cause rejection of the plant. Notify the Owner's Representative of any condition observed.

B. No more plants shall be distributed about the planting bed area than can be planted and watered on the same day.

C. All plant material shall be installed in a sound, workmanlike manner and according to accepted good planting procedures. All elements of landscaping shall be installed so as to meet all applicable ordinances and code requirements.

D. The root system of each plant, regardless of root ball package type, shall be observed by the Contractor, at the time of planting to confirm that the roots meet the requirements for plant root quality in Part 2 Products: Plants General: Plant Quality. The Contractor shall undertake at the

time of planting, all modifications to the root system required by the Owner's Representative to meet these quality standards.

1. Modifications, at the time of planting, to meet the specifications for the depth of the root collar and removal of stem girdling roots and circling roots may make the plant unstable or stress the plant to the point that the Owner's Representative may choose to reject the plant rather than permitting the modification.
2. Any modifications required by the Owner's Representative to make the root system conform to the plant quality standards outlined in Part 2 Products: Plants General: Quality, or other requirements related to the permitted root ball package, shall not be considered as grounds to modify or void the plant warranty.
3. The resulting root ball may need additional staking and water after planting. The Owner's Representative may reject the plant if the root modification process makes the tree unstable or if the tree is not healthy at the end of the warranty period. Such plants shall still be covered under the warranty
4. The Contractor remains responsible to confirm that the grower has made all required root modifications noted during any nursery observations.

E. Container and Boxed Root Ball Shaving: The outer surfaces of ALL plants in containers and boxes, including the top, sides and bottom of the root ball shall be shaved to remove all circling, descending, and matted roots. Shaving shall be performed using saws, knives, sharp shovels or other suitable equipment that is capable of making clean cuts on the roots. Shaving shall remove a minimum of one inch of root mat or up to 2 inches as required to remove all root segments that are not growing reasonably radial to the trunk.

F. Excavation of the Planting Space: Using hand tools or tracked mini-excavator, excavate the planting hole into the Planting Soil to the depth of the root ball measured after any root ball modification to correct root problems, and wide enough for working room around the root ball or to the size indicated on the drawing or as noted below.

1. For trees and shrubs planted in soil areas that are NOT tilled or otherwise modified to a depth of at least 12 inches over a distance of more than 10 feet radius from each tree, or 5 feet radius from each shrub, the soil around the root ball shall be loosened as defined below or as indicated on the drawings.
    a. The area of loosening shall be a minimum of 3 times the diameter of the root ball at the surface sloping to 2 times the diameter of the root ball at the depth of the root ball.
    b. Loosening is defined as digging into the soil and turning the soil to reduce the compaction. The soil does not have to be removed from the hole, just dug, lifted and turned. Lifting and turning may be accomplished with a tracked mini excavator, or hand shovels.
2. The measuring point for root ball depth shall be the average height of the outer edge of the root ball after any required root ball modification.
3. If motorized equipment is used to deliver plants to the planting area over exposed planting beds, or used to loosen the soil or dig the planting holes, all soil that has been driven over shall be tilled to a depth of 6 inches.

G. For trees to be planted in prepared Planting Soil that is deeper than the root ball depth, compact the soil under the root ball using a mechanical tamper to assure a firm bedding for the root ball. If there is more than 12 inches of planting soil under the root ball excavate and tamp the planting soil in lifts not to exceed 12 inches.

H. Set top outer edge of the root ball at the average elevation of the proposed finish. Set the plant plumb and upright in the center of the planting hole. The tree graft, if applicable, shall be visible above the grade. Do not place soil on top of the root ball.

I. The Owner's Representative may request that plants' orientation be rotated when planted based on the form of the plant.

J. Backfill the space around the root ball with the same planting soil or existing soil that was excavated for the planting space. See Specification Section Planting Soil, for requirements to modify the soil within the planting bed.

K. Brace root ball by tamping Planting Soil around the lower portion of the root ball. Place additional Planting Soil around base and sides of ball in six-inch (6") lifts. Lightly tamp each lift using foot pressure or hand tools to settle backfill, support the tree and eliminate voids. DO NOT over compact the backfill or use mechanical or pneumatic tamping equipment. Over compaction shall be defined as greater than 85% of maximum dry density, standard proctor or greater than 250 psi as measured by a cone penetrometer when the volumetric soil moisture is lower than field capacity.

L. Where indicated on the drawings, build a 4 inch high, level berm of Planting Soil around the outside of the root ball to retain water. Tamp the berm to reduce leaking and erosion of the saucer.

M. Thoroughly water the Planting Soil and root ball immediately after planting.

N. Contractor is responsible for removing all tagging tape, plant tags and ties from trees, palms and standard form shrubs not needed for staking or support of trees or palms prior to C.O.

O. Contractor is responsible for removing all support stakes, rebar, guy wires from all palms and trees one year following installation.

P. Provide a minimum vertical clearance on all trees of 8.5' above the sidewalk/pedestrian paths.

Q. Provide a minimum horizontal offset distance of the 2.5' from the back of curb to the future minimum trunk diameter of planted trees.

R. All trees shall be located at least eight feet away from building over-hangs.

3.7 STRAIGHTENING PLANTS

A. Maintain all plants in a plumb position throughout the warranty period. Straighten all trees that move out of plumb including those not staked. Plants to be straightened shall be excavated and the root ball moved to a plumb position, and then re-backfilled. Do not straighten trees or palms by pulling the trunk with guys.

3.8 INSTALLATION OF FERTILIZER AND OTHER CHEMICAL ADDITIVES

A. Fertilizer installation shall adhere to local LDC codes.

B. General fertilization requirements – may vary based upon soil test results:

a. TREES & PALMS
8-2-12 Plus minor elements – min 50% slow release
½ LB. fertilizer per ½ inch caliper
Apply at rootball perimeter, not at base of trunk.

b. SHRUBS AND GROUNDCOVERS
8-2-12 Plus minor elements – min 50% slow release
1.5lbs per 100 SF of landscape area

c. SOD
Liquid fertilizer – min 50% slow release
1 bl. Fertilizer per 1000 SF

3.9 INSTALLATION OF SOD

A. Bahia Grass Lawns:
1. Removal of debris.
   a. Clean areas receiving grass of all stones larger than 1" in diameter, sticks, stumps, paper, glass and other debris. Kill by herbicide and remove all weeds or existing grasses from areas to be sodded.
2. Roto-tilling of all compacted areas.
3. Sub-grading.
4. Removal of additional debris as required.
5. Fine grading.
6. Placement of sod.
7. Clean up.
8. Watering.
9. Maintenance (including watering of all areas regardless of whether or not a sprinkler system has been installed).
10. Application of fertilizer shall begin after installation of sod, when established (two weeks maximum period).
11. Rolling of sod as soon as practical.
12. Regular mowing.

3.10 MULCHING OF PLANTS

A. The contractor shall mulch all new plant material thoroughly and completely to a 3 inch minimum depth with clean, weed free, class A mulch or rock mulch as specified in the plant legend.

B. Contractor responsible for verifying rock mulch, wood mulch and pine needle mulch areas prior to installation. All rock mulch areas shall have filter fabric laid prior to spreading of rock.

C. For trees planted in lawn areas the mulch shall extend to a 5 foot radius around the tree or to the extent indicated on the plans.

D. Lift all leaves, low hanging stems and other green portions of small plants out of the mulch if covered.

3.11 PLANTING BED FINISHING

A. After planting, smooth out all grades between plants before mulching.

B. Separate the edges of planting beds and lawn areas with a smooth, formed edge cut into the turf with the bed mulch level slightly lower, 1 and 2 inches, than the adjacent turf sod or as directed by the Owner's Representative. Bed edge lines shall be as depicted on the drawings.

3.12 WATERING

A. The Contractor shall be fully responsible to ensure that adequate water is provided to all plants from the point of installation until the date of Substantial Completion Acceptance. The Contractor shall adjust the automatic irrigation system, if available, and apply additional or adjust for less water using hoses as required.

B. All landscape areas to be irrigated with a fully automated irrigation system - refer to Irrigation Plans and Irrigation Details.

C. All watering must be done in compliance with local water restriction rule.

D. Hand water root balls of all plants to assure that the root balls have moisture above wilt point and below field capacity. Test the moisture content in each root ball and the soil outside the root ball to determine the water content.

3.13 CLEAN-UP

A. During installation, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week
   1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.
   2. The project site shall remain clean and free of debris and trash and shall be cleaned by the landscape contractor at the end of each working day. Site shall remain clean and orderly at all times. All materials, products, and equipment shall be stored in an organized fashion in an area specified by the owner's representative.

B. Once installation is complete, wash all soil from pavements and other structures. Ensure that mulch is confined to planting beds and that all tags and flagging tape are removed from the site. The Owner's Representative's seals are to remain on the trees and removed at the end of the warranty period.

C. Make all repairs to grades, ruts, and damage by the plant installer to the work or other work at the site.

D. Remove and dispose of all excess planting soil, subsoil, mulch, plants, packaging, and other material brought to the site by the Contractor.

3.14 PROTECTION DURING CONSTRUCTION

A. Landscape contractor shall agree to assume responsibility for job site conditions during the course of construction of this project both during and outside of working hours. Safety of all persons and property shall apply throughout duration of installation work. The landscape

contractor shall defend, indemnify and hold the owner harmless from any and all liability, real or alleged, in the connection with the performance of work on this project.

B. The Contractor shall protect planting and related work and other site work from damage due to planting operations, operations by other Contractors or trespassers. Maintain protection during installation until Substantial Completion Acceptance. Treat, repair or replace damaged work immediately.

C. Damage done by the Contractor, or any of their sub-contractors to existing or installed plants, or any other parts of the work or existing features to remain, including roots, trunk or branches of large existing trees, soil, paving, utilities, lighting, irrigation, other finished work and surfaces including those on adjacent property, shall be cleaned, repaired or replaced by the Contractor at no expense to the Owner. The Owner's Representative shall determine when such cleaning, replacement or repair is satisfactory.

3.15 PLANT MAINTENANCE PRIOR TO SUBSTANTIAL COMPLETION ACCEPTANCE

A. During the project work period and prior to Substantial Completion Acceptance, the Contractor shall maintain all plants.

B. Maintenance during the period prior to Substantial Completion Acceptance shall consist of pruning, watering, cultivating, weeding, mulching, mowing, removal of dead material, repairing and replacing of tree stakes, tightening and repairing of guys, repairing and replacing of damaged tree wrap material, resetting plants to proper grades and upright position, and furnishing and applying such sprays as are necessary to keep plantings reasonably free of damaging insects and disease, and in healthy condition. The threshold for applying insecticides and herbicide shall follow established Integrated Pest Management (IPM) procedures. Mulch areas shall be kept reasonably free of weeds, grass.

3.16 SUBSTANTIAL COMPLETION ACCEPTANCE

A. Upon written notice from the Contractor, the Owners Representative shall review the work and make a determination if the work is substantially complete.
   1. Notification shall be at least 7 days prior to the date the contractor is requesting the review.

B. The date of substantial completion of the planting shall be the date when the Owner's Representative accepts that all work in Planting, Planting Soil, and Irrigation installation sections is complete.

C. The Plant Warranty period begins at date of written notification of substantial completion from the Owner's Representative. The date of substantial completion may be different than the date of substantial completion for the other sections of the project.

D. Prior to issuing substantial completion notice the contractor shall submit to the owner three (3) copies of As-Built plans/documents and three (3) copies of an annualized maintenance and operation manual detailing all schedules, nursery practices, watering requirements, fertilization, trimming, etc., for all plant materials and plant areas of the project.

E. Contractor to request inspection of project in writing to City of Sanibel Natural Resources Department. If all work is satisfactory and complete in accordance with conditions of contract documents, then the owner and landscape architect shall declare substantially complete.

Substantial completion constitutes the beginning of the guarantee period and the 90 day establishment period of maintenance.

F. The landscape contractor is responsible for complete maintenance of all planting areas (including watering, spraying, mulching, mowing, fertilizing, weed removal etc.) through the course of the project. The project will not be accepted or deemed substantially complete by zones or phases unless otherwise noted on the plans or authorized by the Client and General Contractor.

3.17 MAINTENANCE DURING THE WARRANTY PERIOD BY THE PLANT INSTALLER

A. During the warranty period, provide all maintenance for all plantings to keep the plants in a healthy state and the planting areas clean and neat.

B. General requirements.
1. All installation general requirements apply to maintenance.
2. All chemical and fertilizer applications shall be made by licensed applicators for the type of chemicals to be used. All work and chemical use shall comply with all applicable local, provincial and federal requirements.
3. Assure that hoses and watering equipment and other maintenance equipment does not block paths or be placed in a manner that may create tripping hazards. Use standard safety warning barriers and other procedures to maintain the site in a safe manner for visitors at all times.
4. All workers shall wear required safety equipment and apparel appropriate for the tasks being undertaken.
5. The Contractor shall not store maintenance equipment at the site at times when they are not in use unless authorized in writing by the Owner's Representative.
6. Maintenance vehicles shall not park on the site including walks and lawn areas at any time without the Owner's Representative's written permission.
7. Maintain a detailed log of all maintenance activities including types of tasks, date of task, types and quantities of materials and products used, watering times and amounts, and number of each crew. Periodically review the logs with the Owner's Representative, and submit a copy of the logs at the end of each year of the maintenance agreement.
8. Meet with the Owner's Representative a minimum of three times a year to review the progress and discuss any changes that are needed in the maintenance program. At the end of the warranty period attend a hand over meeting to formally transfer the responsibilities of maintenance to the Owner's Representative. Provide all information on past maintenance activities and provide a list of critical tasks that will be needed over the next 12 months. Provide all maintenance logs and soil test data. Make the Contractor's supervisor available for a minimum of one year after the end of the warranty period to answer questions about past maintenance.

C. PROVIDE THE FOLLOWING MAINTENANCE TASKS:
1. Watering:
   a. Provide all water required to keep soil within and around the root balls at optimum moisture content for plant growth.
   b. Maintain all watering systems and equipment and keep them operational
   c. Monitor soil moisture to provide sufficient water. Check soil moisture and root ball moisture with a soil moisture meter on a regular basis and record moisture readings. Do not over water.
   d. Adjust automatic irrigation to reduce watering during rainy season, pending rainfall, and immediately on any signs of overwatering related stress.

2. Plant pruning: Remove cross over branching, shorten or remove developing co dominant leaders, dead wood and winter-damaged branches. Unless directed by the Owner's Representative, do not shear plants or make heading cuts.
3. Restore plants: Reset any plants that have settled or are leaning as soon as the condition is noticed.
4. Guying and staking: Maintain plant guys in a taught position. Remove tree guys and staking after the first full growing season unless directed by Owner's Representative.
5. Weed control: Keep all beds free of weeds. Hand-remove all weeds and any plants that do not appear on the planting plan. Chemical weed control is permitted only with the approval of the Owner's Representative. Schedule weeding as needed but not less 12 times per year.
6. Trash removal: Remove all trash and debris from all planting beds and maintain the beds in a neat and tidy appearance. The number of trash and debris removal visits shall be no less than 12 times per year and may coincide with other maintenance visits.
7. Plant pest control: Maintain disease, insects and other pests at manageable levels. Manageable levels shall be defined as damage to plants that may be noticeable to a professional but not to the average person. Use least invasive methods to control plant disease and insect outbreaks.
8. Plant replacement: Replace all plants that are defective as defined in the warranty provisions, as soon as the plant decline is obvious and in suitable weather and season for planting as outlined in above sections. Plants that become defective during the maintenance period shall be covered and replaced under the warranty provisions.
9. Mulch: Refresh mulch once a year to maintain complete coverage but do not over mulch. At no time shall the overall mulch thickness be greater that 4 inches. Do not apply mulch within 6 inches of the trunks or stems of any plants. Replacement mulch shall meet the requirements of the original approved material. Mulch shall be no more than one inch on top of the root ball surface.
10. Bed edging: Check and maintain edges between mulch and lawn areas in smooth neat lines as originally shown on the drawings.
11. Damage from site use: Repair of damage by site visitors and events, beyond normal wear, are not part of this maintenance. The Owner's Representative may request that the Contractor repair damage beds or plantings for an additional cost. All additional work shall be approved in advance by the Owner's Representative.

3.18 END OF WARRANTY FINAL ACCEPTANCE / MAINTENANCE OBSERVATION

A. At the end of the Warranty and Maintenance period the Owner's Representative shall observe the work and establish that all provisions of the contract are complete and the work is satisfactory.
   1. If the work is satisfactory, the maintenance period will end on the date of the final observation.
   2. If the work is deemed unsatisfactory, the maintenance period will continue at no additional expense to the Owner until the work has been completed, observed, and approved by the Owner's Representative.

B. FAILURE TO PASS OBSERVATION: If the work fails to pass final observation, any subsequent observations must be rescheduled as per above. The cost to the Owner for additional observations will be charged to the Contractor at the prevailing hourly rate of the Owners Representative.

END OF SECTION 32 93 00