



FLORIDA DEPARTMENT
OF TRANSPORTATION

Attachment A

TECHNICAL SPECIAL PROVISIONS

FOR

**FDOT DISTRICT 1 HEADQUARTERS
LOBBY RENOV. / SECURITY MODIFICATIONS**

FM# 438659-1-52-01

FDOT FIXED CAPITAL OUTLAY PROGRAM

100% CD

NOVEMBER 9, 2017

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SECTION 21 00 00 - FIRE PROTECTION REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General provisions of Section 01 00 00 Procurement and Contracting Requirements shall apply to all work.
- B. 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. Work herein shall conform to all applicable laws, ordinances, and to regulations of the local utility companies. The general conditions and all requirements of the contract documents shall apply to all work of this section. Work shall be in accordance with the requirements of:
 - 1. State of Florida, Department of Insurance, Division of State Fire Marshal - Uniform Fire Safety Rules and Regulations (Florida Statute 633).
 - 2. 2011 National Electrical Code
 - 3. Florida Building Code (FBC) 5th Edition (2014): This code includes The 2014 FBC Building, Mechanical, Plumbing, Fuel Gas and Energy Conservation Volumes. Further, see "Referenced Standards" in the FBC, Building Chapter 35; FBC, Plumbing Chapter 14; FBC, Mechanical Chapter 15; FBC, Fuel Gas Chapter 8, FBC, Energy Conservation Chapter 5.) (Effective June 30, 2015)
 - 4. 5th Edition of the Florida Fire Prevention Code (FFPC): (This code also includes the Florida versions of NFPA 1 and NFPA 101.) (Effective December 31, 2014)
 - 5. State of Florida, Department of Environmental Regulation Rules
 - 6. Local Utility Codes
- B. Cooperate with all other trades and install work as fast as the progress of the job will permit.
- C. Use only mechanics skilled in the work they are to perform and have a competent representative on the job when any work is being done.
- D. No work shall be done unless the Superintendent of the Contractor is on the job site. Work shall be properly protected, all rubbish removed promptly, and exposed work shall be carefully cleaned prior to final acceptance.

- E. The term "provide" shall include labor, materials, and equipment necessary to furnish and install, complete and operable, the item or system indicated.
- F. In decisions arising from discrepancies, interpretation of Drawings and Specifications, substitutes, and other pertinent matters, the decision of the Owner's representative's approval shall be final.

1.3 SPECIFICATIONS AND DRAWINGS

- A. Plans show location of fixtures and equipment and are intended to depict the general intent of the work in scope, layout and quality of workmanship. They are not intended to show in minute detail every or all accessories intended for the purpose of executing the work, but it is understood that such details are a part of this work.
- B. Where Drawings and Specifications conflict, it shall be the responsibility of this Contractor to bring such conflict to the attention of the Architect/Engineer for clarification. Refer to Supplementary Conditions, Paragraph 1.2. In general, the Architectural Drawings shall take precedence over the Mechanical Drawings with reference to building construction. All changes from the Drawings necessary to make the work conform with the building as constructed and to fit the work of other trades or to conform to the rules of authorities having jurisdiction, shall be made by the Contractor at his own expense.
- C. Keep a record of the locations of concealed work and of any field changes in Contract Drawings and Specifications for each trade and, upon completion of the job. Refer to Specification Section 017000, "Closeout" for requirements.

1.4 PERMITS, FEES AND INSPECTIONS:

- A. The Contractor shall give all necessary notices, obtain all permits and pay all government fees in accordance with the Supplementary Conditions, sales taxes and other costs, including utility connections or extensions, in connection with this work; file all permit applications required by all governmental departments having jurisdiction.
- B. Obtain all required certificates of inspection for work and deliver them to the Owner before requesting acceptance and final payment for the work.
- C. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and drawings required to comply with all applicable laws, ordinances, rules and regulations.
- D. The Contractor shall inform the Owner of any work or materials which conflict with any of the applicable codes, standards, laws and regulations before submitting his bid.

1.5 GENERAL

- A. Materials or products specified herein and/or indicated on drawings by trade name, manufacturer's name and/or catalog number shall be provided as specified. Substitutions will not be permitted except as described herein and in the Supplementary and General Conditions.
- B. Since manufacturers reserve the right to change their products at any time, contractors shall verify all dimensions, performance data, etc. for each piece of equipment submitted to assure compliance with the intent of the drawings and specifications.
- C. All materials shall be new and of quality as specified, and when available, be clearly labeled and/or stamped as manufactured in the United States.
- D. Where an accepted substitution or deviation requires different quantity or arrangement of foundations, supports, ductwork, piping, wiring, conduit, and any other equipment or accessories normal to this equipment, contractor shall furnish said changes and additions and pay all costs for all changes and additions to his work and the work of others affected by this substitution or deviation.
- E. Deviations mean the use of any listed approved manufacturer other than those on which the drawings are based.

1.6 SHOP AND ERECTION DRAWINGS AND SAMPLES

- A. The Architect/Engineer's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site. Submittals shall be made for all equipment and systems as indicated in the respective specification section.
- B. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Architect/Engineer to ascertain that the proposed equipment and materials comply with specification and drawing requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- C. Shop and erection drawing submittals shall conform to the requirements of the General Conditions and Division 00 specifications except as modified herein.
- D. Submit required and/or requested shop and erection drawings, for review by Architect/Engineer before ordering or installing any equipment or material. Equipment or material ordered or installed before Architect/Engineer review may not be accepted and may have to be removed from the project if deemed unacceptable.

- E. Shop drawings shall consist of manufacturer's scale drawings, cuts or catalogs, including descriptive literature which shall clearly indicate the construction, material, physical dimensions, wiring diagrams and complete operating data clearly marked for each item. Data of general nature will not be accepted.
- F. Shop drawings on paper larger than 11"x17" shall be submitted in the form of one set of reproducibles (vellum) and one set of blueprints. The blueprints will be retained by the engineer and the reproducibles will be returned to the contractor.
 - 1. Coordination drawings shall show major elements, components, and systems of mechanical equipment and materials in relationship with other building components. Prepare drawings to an accurate scale of 1/4"=1'-0" or larger. Indicate the locations of all equipment and materials, including clearances for installing, servicing and maintaining equipment, valve stem movement, and similar requirements. Indicate movement and positioning of large equipment into the building during construction.
- G. Submittals for individual systems and equipment assemblies which 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 for approval. Submittals shall be submitted for all applicable products and materials specified in each individual section of these specifications.
- H. Make submittals for the equipment and materials in accordance with the following:
 - 1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
 - 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 - 3. The submittals shall include the following:
 - a. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required. Provide any additional information specifically requested in the individual specification section or on the drawings.
 - b. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
 - 4. Electronic PDF submittal files shall be named utilizing the specification number followed by a sequential number for the submittal made under the given specification number followed by "r#" if it is a resubmittal, and then followed by a brief description of the submitted item.

- a. The description shall indicate the actual item submitted, shall not be general in nature, and does not have to be that of the specification section heading.
 - b. Using the example, “210529-4r2 Hangers”; 210529 – Fire Protection Supports and Anchors is the relevant specification, the “4” shows it was the fourth submittal for specification section 210519 02, “r2” shows it was the second resubmittal, and the description indicates what item is submitted.
 - c. Each specification item shall be submitted in a separate PDF file. PDF files with multiple specification items will be returned without review.
 - d. Each file shall have sufficient space allowance for the Architects and Engineer’s review stamp(s).
 - e. Each file shall have the Constructors Managers review stamp(s) and indicate information required by specification 210000.1.5K.
- I. Shop drawings on paper 11”X17” or smaller in size shall be submitted in a tabbed and indexed three ring binder. The binder shall not exceed 11-5/8” height. Partial submittals are unacceptable. The index shall indicate the related specification section number.
 - J. A fee will be charged for Engineering review plans that have been rejected two or more times due to non-compliance or incompleteness. The fee will be determined by the Architect/Engineer and the CM will backcharge the responsible subcontractor and will reimburse the owner by change order for the additional fees.
 - K. The Construction Manager will certify that all Division 21 shop drawings are in conformance with the plans and specifications. Deviations from the plans and specifications shall be noted, and the specific area of the deviation clouded and in contrasting color (green) with a complete explanation for the reasons for the deviation. Any redesign of the system shall be Certified by a Professional Engineer currently registered in the State of Florida, and will be accompanied by the fees as described in “J” above.
 - L. Carefully examine all shop drawings and mark-up as necessary before submitting to the Architect/Engineer for review. The consultant will only consider shop drawings bearing the contractor’s stamp of approval.
 - M. The engineer’s review shall not relieve the contractor from the responsibility for deviations from drawings and specifications. The engineer’s review shall be construed to apply only to general arrangement and shall not relieve the contractor from the responsibility for the correctness of details and dimensions and provision of the correct equipment.

- N. The contractor shall retain copies of all reviewed shop drawings on the job site for reference.
- O. In addition to the requirement of SUBMITTALS, the Owner reserves the right to request the manufacturer to arrange for the Owner's representative(s) to see typical active systems in operation, when there has been no prior experience with the manufacturer or the type of equipment being submitted.

1.7 EXPERIENCE

- A. The Contractor performing this work shall be a licensed, reputable firm, regularly performing the type of work incorporated in this project and who also maintains, as part of the firm, a service department with qualified personnel who regularly perform this type of work. The Contractor shall, upon request, show evidence of at least two jobs of similar character and size installed within the preceding two years.

1.8 COORDINATION WITH OTHER TRADES

- A. Contractor shall coordinate his work with other trades to avoid interferences and delays. He shall assist in working out space requirements to make a satisfactory installation.
- B. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with the work of other trades, he shall make the necessary changes in his work to correct the condition without extra charge.
- C. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

1.9 STORAGE OF MATERIALS

- A. All materials stored on site shall be properly protected from injury or deterioration. Materials shall not be stored in contact with ground or floor.
- B. Do not remove manufacturer's packing materials until ready to install. Materials showing signs of corrosion, improper handling or storage shall be replaced at no cost to the Owner.
- C. Provide continuous protection for all equipment already installed.

1.10 CUTTING, PATCHING, EXCAVATION, BACKFILL, AND LAYOUT

- A. Provide openings and excavation required for the installation of the work. Patch work and backfill as required. Finished work shall match the existing adjoining work.

- B. Verify all conditions affecting the work to be performed under this contract.
- C. Carefully verify measurements at the site, determine the exact location of chases and openings required. Provide sleeves, inserts, and hangers as required. No columns, beams, joists, building foundations or any other structural building component shall be cut, drilled or disturbed in any way. Conflicts shall immediately be brought to the attention of the Architect/Engineer.
- D. All excavation on sites containing existing buildings and existing services shall be done with hand shovel to avoid damage to existing services. Any damage incurred by the Contractor shall be repaired by the Contractor in a manner approved by the Architect/Engineer at no cost to the Owner and with no extension of time limitation.

1.11 REMOVAL OF RUBBISH

- A. Contractor shall keep premises free from accumulations of waste material or rubbish caused by his employees or work in accordance with Division 00 - Construction Procedures. At completion of work, he shall remove all his tools, scaffolding, surplus materials, and rubbish from building and site. He shall leave premises and his work in a clean orderly condition acceptable to the Architect/Engineer.

1.12 QUIET OPERATION AND VIBRATION

- A. All equipment provided under this section shall operate under all conditions of load free of objectionable sound and vibration. Sound and vibration conditions considered objectionable shall be corrected in an approved manner.
- B. Vibration and sound control shall be by means of approved vibration eliminators or sound attenuators in a manner as specified and as recommended by the manufacturer.

1.13 EQUIPMENT IDENTIFICATION

- A. Each unit shall be identified by its system number and other appropriate designation by stenciling in letters of approved size and wording. Equipment requiring identification shall include: supply and exhaust fans, air conditioning and heating machinery and apparatus, pumps, piping, control cabinets, and other equipment units as may be directed by the Architect/Engineer.

1.14 CLEANING AND ADJUSTMENTS

- A. Upon completion of the work, Contractor shall clean and lubricate fans, motors, and other running equipment and apparatus which he has installed and make certain such apparatus and mechanisms are in proper working order and ready to test.
- B. Scratched or damaged painting shall be touched up as necessary to return the painting to "new" condition and appearance.

- C. All piping and equipment shall be thoroughly blown out under pressure and cleared of all foreign matter, wasting air, gas or water through temporary connections as long as necessary to thoroughly clean system before system is placed in operation. Use every precaution to prevent pipe compound, scale, dirt, welding and other objectionable matter from getting into the piping system and equipment.
- D. During blow out period, baskets from strainers shall be removed, traps and control valves, etc., shall be by-passed.
- E. All cleaning shall be done prior to any sterilization, pressure testing, flow balancing or equipment adjustment procedures.
- F. During construction protect all piping and equipment from damage and dirt. Cap the open ends of all piping and equipment.

1.15 WATERPROOFING

- A. Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as approved by the Owner before the work is done.
- B. Provide all necessary sleeves, caulking and flashing required to make openings absolutely watertight. Waterproof flashing materials shall be compatible with base materials.

1.16 TESTS

- A. Contractor shall make all tests required to establish the adequacy, quality, safety, completed status and satisfactory operation of all systems to the satisfaction of the Architect/Engineer. Provide all instruments, labor and services necessary to conduct tests.

1.17 INSTRUCTIONS

- A. Fully instruct Owner's personnel in the care and operation of mechanical systems and furnish a letter to the Architect/Engineer advising the particular person who has received such instruction.

1.18 WARRANTY

- A. Equipment shall be started, tested, adjusted, and placed in satisfactory operating condition. Furnish a letter addressed to the Architect/Engineer advising that the completed systems have been installed in accordance with the Plans and Specifications and that they are in proper operating condition. The Owner shall receive a written warranty covering all defects in workmanship and material for a period of one year from date of final acceptance. Any defects appearing within this one year period shall be repaired without additional cost to the Owner.

1.19 ACCEPTANCE

- A. Before requesting final inspection:
 - 1. Complete all work required. If any items are held in abeyance as incomplete for final inspection, list such items together with explanation for delay.
 - 2. Submit statement that equipment is properly installed, adjusted, fully lubricated and operation is satisfactory.
 - 3. Certify in writing to the Architect/Engineer that the Owner's representative has been instructed as to the care and operation of the system and that catalog service and maintenance information has been turned over to the Architect/Engineer.
 - 4. Submit copy of written guarantee.
 - 5. Submit copy of other data as may be outlined in these specifications.
- B. Copies of the above data shall be submitted to the Architect/Engineer prior to requesting final inspection.

1.20 FACILITY STARTUP BROCHURE

- A. At the completion of work, Contractor shall provide startup instruction in accordance with Division 00, "Closeout" and shall submit a bound brochure containing the following:
 - 1. Shop Drawings
 - 2. Maintenance Manuals
 - 3. Control Wiring and Piping Diagrams
 - 4. Operating Instructions
 - 5. Copy of Guarantee
 - 6. Certificate of Instruction of Owner's Representative
 - 7. Certificate of Job Completion
 - 8. Record Documents
- B. Where projects are of sufficient size to make a single brochure impractical, several brochures shall be prepared by trade and As-Built Drawings may be submitted as a separate item.
- C. Brochure shall be indexed and divided for reasonable clarity.

- D. Brochure shall be turned over to the Architect/Engineer for review and approval. The contractor shall make modifications to the brochure as deemed necessary for compliance and clarity, by the Architect/Engineer, and re-submit the final brochure to the Architect/Engineer to be forwarded to the Owner.

END OF SECTION 21 00 00

SECTION 21 22 00 - CLEAN-AGENT FIRE-EXTINGUISHING 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. Piping and piping specialties.
- 2. Extinguishing-agent containers.
- 3. Extinguishing agent.
- 4. Detection and alarm devices.
- 5. Control and alarm panels.
- 6. Accessories.
- 7. Connection devices for and wiring between system components.
- 8. Connection devices for power and integration into building's fire-alarm system.

1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. EPO: Emergency Power Off.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For clean-agent fire-extinguishing system signed and sealed by a qualified professional engineer registered in the State of Florida.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include all design calculations.
 - 3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

4. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For clean-agent fire-extinguishing system signed and sealed by the qualified professional engineer.
1. Indicate compliance with performance requirements and design criteria, including analysis data.
 2. Include design calculations for weight, volume, and concentration of extinguishing agent required for each hazard area.
 3. Indicate the Following on Reflected Ceiling Plans:
 - a. Ceiling penetrations and ceiling-mounted items.
 - b. Extinguishing-agent containers if mounted above floor, piping and discharge nozzles, detectors, and accessories.
 - c. Method of attaching hangers to building structure.
 - d. Other ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
 4. Indicate the Following on Occupied Work Area Plans:
 - a. Controls and alarms.
 - b. Extinguishing-agent containers, piping and discharge nozzles if mounted in space, detectors, and accessories.
 - c. Equipment and furnishings.
 5. Indicate the Following on Access Floor Space Plans:
 - a. Extinguishing-agent containers, piping and discharge nozzles, detectors, and accessories.
 - b. Method of supporting piping.
 6. Indicate the Following on Ceiling Plans:
 - a. Extinguishing-agent containers, piping and discharge nozzles, detectors, and accessories.
 - b. Method of supporting piping.
 - c. Other equipment located in the ceiling space that is being protected including sprinkler piping, HVAC equipment, raceways, or conduit.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Domestic water piping.
 - 2. Items Penetrating Finished Ceiling Include the Following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Life Safety fixtures.
 - d. Speakers.
 - 3. HVAC equipment.
 - 4. Data equipment.
- B. Permit Approved Drawings: Working plans, prepared according to NFPA 2001 and NFPA 75, that have been approved by authorities having jurisdiction. Include design calculations.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For special agent system to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
 - 1. Detection Devices: Not less than 20 percent of amount of each type installed.
 - 2. Container Valves: Not less than 10 percent of amount of each size and type installed.
 - 3. Nozzles: Not less than 20 percent of amount of each type installed.
 - 4. Extinguishing Agent: Not less than 100 percent of amount installed in largest hazard area. Include pressure-rated containers with valves.

1.8 QUALITY ASSURANCE

- 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. FM Global Compliance: Provide components that are FM Approved and that are listed in FM Global's "Approval Guide."
- C. UL Compliance: Provide equipment listed in UL's "Fire Protection Equipment Directory."
- D. System shall be installed by a factory certified company that has been in business for 5 years minimum.

1.9 WARRANTY

- A. Warranty: Repair or replace components that fail in materials or workmanship. Manufacturer's warranty shall be in the name of the Owner.
 - 1. Warranty Period: One year minimum from date of Substantial Completion, or longer if standard manufacturer's warranty is longer.

PART 2 - PRODUCTS

2.1 CLEAN-AGENT SYSTEMS

- A. Description: Clean-agent fire-extinguishing system shall be an engineered system for total flooding of the hazard area including the room cavity below the ceiling and above floor.
- B. Delegated Design: Design clean-agent fire-extinguishing system and obtain approval from authorities having jurisdiction. Design system for Class A, B, and C fires as appropriate for areas being protected, and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.
- C. Performance Requirements: Discharge FM-200 in designated hazard areas.
- D. Verified Detection: Devices located in single zone. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating second-detection device.
- E. System Operating Sequence:
 - 1. Actuating First Detector: Visual indication on annunciator panel. Energize audible and visual alarms (slow pulse), shut down air-conditioning and ventilating systems serving protected area, close doors in protected area, and send signal to fire-alarm system.

2. Actuating Second Detector: Visual indication on annunciator panel. Energize audible and visual alarms (fast pulse), shut down power to protected equipment, start time delay for extinguishing-agent discharge for 30 seconds, and discharge extinguishing agent. On agent discharge, release pre-action valve to allow water to fill sprinkler system.
 3. Extinguishing-agent discharge will operate audible alarms and strobe lights inside and outside the protected area.
- F. Manual stations shall immediately discharge extinguishing agent when activated.
 - G. Operating abort switches will delay extinguishing-agent discharge while being activated, and switches must be reset to prevent agent discharge. Release of hand pressure on the switch will cause agent discharge if the time delay has expired.
 - H. EPO: Will terminate power to protected equipment immediately on actuation.
 - I. Low-Agent Pressure Switch: Initiate trouble alarm if sensing less than set pressure.
 - J. Power Transfer Switch: Transfer from normal to stand-by power source.
 - K. Seismic Performance: Fire-suppression piping and containers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 1. The term “withstand” means “the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.”

2.2 PIPING MATERIALS

- A. System manifold piping shall be constructed to withstand a minimum pressure of 3000 psi. Distribution piping downstream from the orifice union shall be constructed to withstand the maximum downstream pressure s determined by the flow calculation.
- B. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001, Section “Distribution,” for charging pressure of system.

2.3 PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, Type S, Grade B or ASTM A 106/A 106M, Grade A; Schedule 40, Schedule 80, and Schedule 160, seamless steel pipe.
 1. Threaded Fittings:
 - a. Malleable-Iron Fittings: ASME B16.3, Class 300.

- b. Flanges and Flanged Fittings: ASME B16.5, Class 300 unless Class 600 is indicated.
 - c. Fittings Working Pressure: 620 psig minimum.
 - d. Flanged Joints: Class 300 minimum.
- 2. Forged-Steel Welding Fittings: ASME B16.11, Class 3000, socket pattern.
- 3. Steel, Grooved-End Fittings: FM Approved and NRTL listed, ASTM A 47/A 47M malleable iron or ASTM A 536 ductile iron, with dimensions matching steel pipe and ends factory grooved according to AWWA C606.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
- D. 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.
- E. Steel, Keyed Couplings: UL 213, AWWA C606, approved or listed for clean-agent service, and matching steel-pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gasket, and steel bolts and nuts.

2.4 VALVES

- A. General Valve Requirements:
 - 1. UL listed or FM Approved for use in fire-protection systems.
 - 2. Compatible with type of clean agent used.
- B. Container Valves: With rupture disc or solenoid and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.
- C. Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.
- D. Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

2.5 EXTINGUISHING-AGENT CONTAINERS

- A. Description: Steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.
 - 1. Finish: Red, enamel or epoxy paint.
 - 2. Manifold: Fabricate with valves, pressure switches, and connections for multiple storage containers, as indicated.
 - 3. Manifold: Fabricate with valves, pressure switches, selector switch, and connections for main- and reserve-supply banks of multiple storage containers.
 - 4. Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

2.6 FIRE-EXTINGUISHING CLEAN AGENT

- A. FM-200.

2.7 DISCHARGE NOZZLES

- A. Equipment manufacturer's standard, discharge pattern, and capacity required for application.

2.8 MANIFOLD AND ORIFICE UNIONS

- A. Description: NRTL-listed device with minimum 3000-psig pressure rating, to control flow and reduce pressure of FM-200 gas in piping.
 - 1. NPS 2 and Smaller: Piping assembly with orifice, sized for system design requirements.
 - 2. NPS 2-1/2 and Larger: Piping assembly with nipple, sized for system design requirements.

2.9 CONTROL PANELS

- A. Description: FM Approved or NRTL listed, including equipment and features required for testing, supervising, and operating fire-extinguishing system.
- B. Power Requirements: 120/240-V ac; with electrical contacts for connection to system components and fire-alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.

- C. Enclosure: NEMA ICS 6, Type 1, enameled-steel cabinet.
 - 1. Mounting: Recessed flush with surface.
- D. Supervised Circuits: Separate circuits for each independent hazard area.
 - 1. Detection circuits using addressable devices assigned to the required number of zones.
 - 2. Manual pull-station circuit.
 - 3. Alarm circuit.
 - 4. Release circuit.
 - 5. Abort circuit.
 - 6. EPO circuit.
- E. Control-Panel Features:
 - 1. Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.
 - 2. Automatic switchover to standby power at loss of primary power.
 - 3. Storage container, low-pressure indicator.
 - 4. Service disconnect to interrupt system operation for maintenance with visual status indication on the annunciator panel.
- F. Annunciator Panel: Graphic type showing protected, hazard-area plans, as well as locations of detectors and abort, EPO, and manual stations. Include lamps to indicate device-initiating alarm, electrical contacts for connection to control panel, and stainless-steel or aluminum enclosure.
- G. Standby Power: Sealed lead calcium batteries with capacity to operate system for 24 hours and alarm for minimum of 15 minutes. Include automatic battery charger that has a varying charging rate between trickle and high depending on battery voltage, and that is capable of maintaining batteries fully charged. Include manual voltage control, dc voltmeter, dc ammeter, electrical contacts for connection to control panel, automatic transfer switch, and suitable enclosure.

2.10 DETECTION DEVICES

- A. General Requirements for Detection Devices:
 - 1. Comply with NFPA 2001, NFPA 72, and UL 268.

2. 24-V dc, nominal.
 3. Provide all required smoke detection devices as part of the clean agent systems. These are not “building” fire alarm smoke detectors.
- B. Ionization Detectors: Dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.
- C. Photoelectric Detectors: LED light source and silicon photodiode receiving element.
- D. Remote Air-Sampling Detector System: Includes air-sampling pipe network, a laser-based photoelectric detector, a sample transport fan, and a control unit.
1. Pipe Network: CPVC tubing connects control unit with calibrated sampling holes.
 2. Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of four preset values.
 3. Sample Transport Fan: Centrifugal type, creating a minimum static pressure of 0.05-inch wg at all sampling ports.
 4. Control Unit: Multizone unit as indicated on Drawings. Provides same system power supply, supervision, and alarm features as specified for the control panel plus separate trouble indication for airflow and detector problems.
- E. Signals to the Central Fire Alarm Control Panel: Any type of local system trouble is reported to the central fire alarm control panel as a composite “trouble” signal. Alarms on each system zone are individually reported to the central fire alarm control panel as separately identified zones.

2.11 MANUAL STATIONS

- A. General Description: Surface FM Approved or NRTL listed, with clear plastic hinged cover, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.
- B. Manual Release: “MANUAL RELEASE” caption, and red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.
- C. Abort Switch: “ABORT” caption, momentary contact, with green finish.
- D. EPO Switch: “EPO” caption, with yellow finish.

2.12 SWITCHES

- A. Description: FM Approved or NRTL listed, where available, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.
 - 1. Low-Agent Pressure Switches: Pneumatic operation.
 - 2. Power Transfer Switches: Key-operation selector, for transfer of release circuit signal from main supply to reserve supply.
 - 3. Door Closers: Magnetic retaining and release device or electrical interlock to cause the door operator to drive the door closed.

1.1 ALARM DEVICES

- A. Description: Listed and labeled by an NRTL or FM Approved, low voltage, and surface mounting. Comply with requirements in Section 28.31.11 “Digital, Addressable Fire-Alarm System” or Section 28.31.12 “Zoned (DC Loop) Fire-Alarm System” for alarm and monitoring devices.
- B. Bells: Minimum 6-inch diameter.
- C. Horns: 90 to 94 dBA.
- D. Strobe Lights: Translucent lens, with “FIRE” or similar caption.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with hazard-area leakage requirements, installation tolerances, and other conditions affecting work performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PIPING APPLICATIONS

- A. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
- B. NPS 2 and Smaller: Schedule 40, steel pipe; malleable-iron threaded fittings; and threaded joints.
- C. NPS 2-1/2 and Larger: Schedule 40, steel pipe; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.

3.3 CLEAN-AGENT PIPING INSTALLATION

- A. Install clean-agent extinguishing piping and other components level and plumb, according to manufacturers' written instructions.
- B. Grooved Piping Joints: Groove pipe ends according to AWWA C606 dimensions. Assemble grooved-end steel pipe and steel, grooved-end fittings with steel, keyed couplings and lubricant according to manufacturer's written instructions.
- C. Install extinguishing-agent containers anchored to substrate.
- D. Install pipe and fittings, valves, and discharge nozzles according to requirements listed in NFPA 2001, Section "Distribution."
 - 1. Install valves designed to prevent entrapment of liquid, or install pressure relief devices in valved sections of piping systems.
 - 2. Support piping using supports and methods according to NFPA 13.
 - 3. Install seismic restraints for extinguishing-agent containers and piping systems.
 - 4. Install control panels, detection system components, alarms, and accessories, complying with requirements of NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.

3.4 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.
- C. Connect electrical devices to control panel and to building's fire-alarm system. Electrical power, wiring, and devices are specified in Section 28 31 11 "Digital, Addressable Fire-Alarm System".

3.5 IDENTIFICATION

- A. Identify system components and equipment. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify piping, extinguishing-agent containers, other equipment, and panels according to NFPA 2001.
- C. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean-agent fire-extinguishing system.

- D. Install signs at entry doors to advise persons outside the room the meaning of the horn(s), bell(s), and strobe light(s) outside the protected space.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. 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.
- D. Tests and Inspections:
 - 1. After installing clean-agent extinguishing piping system and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections "Inspection and Test Procedures" and "System Function Tests." Certify compliance with test parameters.
 - 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Units will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

3.7 CLEANING

- A. Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, using a suitable nonflammable cleaner. Pipe network shall be free of particulate matter and oil residue before installing nozzles or discharge devices.

3.8 SYSTEM FILLING

A. Preparation:

1. Verify that piping system installation is completed and cleaned.
2. Check for complete enclosure integrity.
3. Check operation of ventilation and exhaust systems.

B. Filling Procedures:

1. Fill extinguishing-agent containers with extinguishing agent, and pressurize to indicated charging pressure.
2. Install filled extinguishing-agent containers.
3. Energize circuits.
4. Adjust operating controls.

3.9 DEMONSTRATION

- #### A.
- Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain clean-agent fire-extinguishing systems.

END OF SECTION 21 22 00

SECTION 23 00 00 - HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Work herein shall conform to all applicable laws, ordinances, and to regulations of the local utility companies. The general conditions and all requirements of the contract documents shall apply to all work of this section. Work shall be in accordance with the requirements of:
 - 1. Florida Building Code (FBC) 5th Edition (2014): This code includes The 2014 FBC Building, Mechanical, Plumbing, Fuel Gas and Energy Conservation Volumes. Further, see "Referenced Standards" in the FBC, Building Chapter 35; FBC, Plumbing Chapter 14; FBC, Mechanical Chapter 15; FBC, Fuel Gas Chapter 8, FBC, Energy Conservation Chapter 5.) (Effective June 30, 2015)
 - 2. 5th Edition of the Florida Fire Prevention Code (FFPC): (This code also includes the Florida versions of NFPA 1 and NFPA 101.) (Effective December 31, 2014)
 - 3. 2011 National Electrical Code
- B. Cooperate with all other trades and install work as fast as the progress of the job will permit.
- C. Use only mechanics skilled in the work they are to perform and have a competent representative on the job when any work is being done.
- D. No work shall be done unless the Superintendent of the Contractor is on the job site. Work shall be properly protected, all rubbish removed promptly, and exposed work shall be carefully cleaned prior to final acceptance.
- E. The term "provide" shall include labor, materials, and equipment necessary to furnish and install, complete and operable, the item or system indicated.
- F. In decisions arising from discrepancies, interpretation of Drawings and Specifications, substitutes, and other pertinent matters, the decision of the Owner's representative's approval shall be final.

1.2 SPECIFICATIONS AND DRAWINGS

- A. Plans show location of fixtures and equipment and are intended to depict the general intent of the work in scope, layout and quality of workmanship. They are not intended to show in minute detail every or all accessories intended for the purpose of executing the work, but it is understood that such details are a part of this work.

- B. Where Drawings and Specifications conflict, it shall be the responsibility of this Contractor to bring such conflict to the attention of the Architect/Engineer for clarification. Refer to Supplementary Conditions, Paragraph 1.2. In general, the Architectural Drawings shall take precedence over the Mechanical Drawings with reference to building construction. All changes from the Drawings necessary to make the work conform with the building as constructed and to fit the work of other trades or to conform to the rules of authorities having jurisdiction, shall be made by the Contractor at his own expense.
- C. Keep a record of the locations of concealed work and of any field changes in Contract Drawings and Specifications for each trade and, upon completion of the job. Refer to Specification Section 017000, "Closeout" for requirements.

1.3 PERMITS, FEES AND INSPECTIONS:

- A. The Contractor shall give all necessary notices, obtain all permits and pay all government fees in accordance with the Supplementary Conditions, sales taxes and other costs, including utility connections or extensions, in connection with this work; file all permit applications required by all governmental departments having jurisdiction.
- B. Obtain all required certificates of inspection for work and deliver them to the Owner before requesting acceptance and final payment for the work.
- C. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and drawings required to comply with all applicable laws, ordinances, rules and regulations.
- D. The Contractor shall inform the Owner of any work or materials which conflict with any of the applicable codes, standards, laws and regulations before submitting his bid.

1.4 GENERAL

- A. Materials or products specified herein and/or indicated on drawings by trade name, manufacturer's name and/or catalog number shall be provided as specified. Substitutions will not be permitted except as described herein and in the Supplementary and General Conditions.
- B. Since manufacturers reserve the right to change their products at any time, contractors shall verify all dimensions, performance data, etc. for each piece of equipment submitted to assure compliance with the intent of the drawings and specifications.
- C. All materials shall be new and of quality as specified, and when required, be clearly labeled and/or stamped as manufactured in the United States.

- D. Where an accepted substitution or deviation requires different quantity or arrangement of foundations, supports, ductwork, piping, wiring, conduit, and any other equipment or accessories normal to this equipment, contractor shall furnish said changes and additions and pay all costs for all changes and additions to his work and the work of others affected by this substitution or deviation.
- E. Deviations mean the use of any listed approved manufacturer other than those on which the drawings are based.

1.5 SHOP AND ERECTION DRAWINGS AND SAMPLES

- A. The Architect/Engineer's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site. Submittals shall be made for all equipment and systems as indicated in the respective specification section.
- B. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Architect/Engineer to ascertain that the proposed equipment and materials comply with specification and drawing requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- C. Shop and erection drawing submittals shall conform to the requirements of the General Conditions and Division 00 specifications except as modified herein.
- D. Submit required and/or requested shop and erection drawings, for review by Architect/Engineer before ordering or installing any equipment or material. Equipment or material ordered or installed before Architect/Engineer review may not be accepted and may have to be removed from the project if deemed unacceptable.
- E. Shop drawings shall consist of manufacturer's scale drawings, cuts or catalogs, including descriptive literature which shall clearly indicate the construction, material, physical dimensions, wiring diagrams and complete operating data clearly marked for each item. Data of general nature will not be accepted.
- F. Shop drawings on paper larger than 11"x17" shall be submitted in the form of one set of reproducibles (vellum) and one set of blueprints. The blueprints will be retained by the engineer and the reproducibles will be returned to the contractor.
 - 1. Coordination drawings shall show major elements, components, and systems of mechanical equipment and materials in relationship with other building components. Prepare drawings to an accurate scale of 1/4"=1'-0" or larger. Indicate the locations of all equipment and materials, including clearances for installing, servicing and maintaining equipment, valve stem movement, and similar requirements. Indicate movement and positioning of large equipment into the building during construction.

- G. Submittals for individual systems and equipment assemblies which 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 for approval. Submittals shall be submitted for all applicable products and materials specified in each individual section of these specifications.
- H. Make submittals for the equipment and materials in accordance with the following:
1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 3. The submittals shall include the following:
 - a. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required. Provide any additional information specifically requested in the individual specification section or on the drawings.
 - b. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
 4. Electronic PDF submittal files shall be named utilizing the specification number followed by a sequential number for the submittal made under the given specification number followed by "r#" if it is a resubmittal, and then followed by a brief description of the submitted item.
 - a. The description shall indicate the actual item submitted, shall not be general in nature, and does not have to be that of the specification section heading.
 - b. Using the example, "230519-4r2 Differential Pressure Gauge"; 230519 – Meters and Gauges is the relevant specification, the "4" shows it was the fourth submittal for specification section 230519 02, "r2" shows it was the second resubmittal, and the description indicates what item is submitted.
 - c. Each specification item shall be submitted in a separate PDF file. PDF files with multiple specification items will be returned without review.
 - d. Each file shall have sufficient space allowance for the Architects and Engineer's review stamp(s).

- e. Each file shall have the Construction Manager's review stamp(s) and indicate information required by specification 230000.1.5.K.
- I. Shop drawings on paper 11"X17" or smaller in size shall be submitted in a tabbed and indexed three ring binder. The binder shall not exceed 11-5/8" height. Partial submittals are unacceptable. The index shall indicate the related specification section number.
- J. A fee will be charged for Engineering review plans that have been rejected two or more times due to non-compliance or incompleteness. The fee will be determined by the Architect/Engineer and the CM will backcharge the responsible subcontractor and will reimburse the owner by change order for the additional fees.
- K. The Construction manager will certify that all Division 23 shop drawings are in conformance with the plans and specifications. Deviations from the plans and specifications shall be noted, and the specific area of the deviation clouded and in contrasting color (green) with a complete explanation for the reasons for the deviation. Any redesign of the system shall be Certified by a Professional Engineer currently registered in the State of Florida, and will be accompanied by the fees as described in "J" above.
- L. Carefully examine all shop drawings and mark-up as necessary before submitting to the Architect/Engineer for review. The consultant will only consider shop drawings bearing the contractor's stamp of approval.
- M. The engineer's review shall not relieve the contractor from the responsibility for deviations from drawings and specifications. The engineer's review shall be construed to apply only to general arrangement and shall not relieve the contractor from the responsibility for the correctness of details and dimensions and provision of the correct equipment.
- N. The contractor shall retain copies of all reviewed shop drawings on the job site for reference.
- O. In addition to the requirement of SUBMITTALS, the Owner reserves the right to request the manufacturer to arrange for the Owner's representative(s) to see typical active systems in operation, when there has been no prior experience with the manufacturer or the type of equipment being submitted.
- P. Operation and Maintenance Manuals:
 - 1. Maintenance manuals shall be complete and shall be furnished in a loose leaf binder or in the manufacturer's standard binder. Information shall be sufficient to enable a qualified technician to perform normal first line maintenance and repair. A parts list shall be included which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.

2. Operation manuals shall be clear and concise and shall describe, in detail, the information required to properly operate the equipment specified. The manuals shall include complete catalog cuts and as-built wiring diagrams.
3. Operation and maintenance manuals shall be submitted for approval prior to final close-out.

1.6 EXPERIENCE

- A. The Contractor performing this work shall be a licensed, reputable firm, regularly performing the type of work incorporated in this project and who also maintains, as part of the firm, a service department with qualified personnel who regularly perform this type of work. The Contractor shall, upon request, show evidence of at least two jobs of similar character and size installed within the preceding two years.

1.7 COORDINATION WITH OTHER TRADES

- A. Contractor shall coordinate his work with other trades to avoid interferences and delays. He shall assist in working out space requirements to make a satisfactory installation.
- B. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with the work of other trades, he shall make the necessary changes in his work to correct the condition without extra charge.
- C. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

1.8 STORAGE OF MATERIALS

- A. All materials stored on site shall be properly protected from injury or deterioration. Materials shall not be stored in contact with ground or floor.
- B. Do not remove manufacturer's packing materials until ready to install. Materials showing signs of corrosion, improper handling or storage shall be replaced at no cost to the Owner.
- C. Provide continuous protection for all equipment already installed.

1.9 CUTTING, PATCHING, EXCAVATION, BACKFILL, AND LAYOUT

- A. Provide openings and excavation required for the installation of the work. Patch work and backfill as required. Finished work shall match the existing adjoining work.
- B. Verify all conditions affecting the work to be performed under this contract.

- C. Carefully verify measurements at the site, determine the exact location of chases and openings required. Provide sleeves, inserts, and hangers as required. No columns, beams, joists, building foundations or any other structural building component shall be cut, drilled or disturbed in any way. Conflicts shall immediately be brought to the attention of the Architect/Engineer.
- D. All excavation on sites containing existing buildings and existing services shall be done with hand shovel to avoid damage to existing services. Any damage incurred by the Contractor shall be repaired by the Contractor in a manner approved by the Architect/Engineer at no cost to the Owner and with no extension of time limitation.

1.10 REMOVAL OF RUBBISH

- A. Contractor shall keep premises free from accumulations of waste material or rubbish caused by his employees or work in accordance with Division 00 - Construction Procedures. At completion of work, he shall remove all his tools, scaffolding, surplus materials, and rubbish from building and site. He shall leave premises and his work in a clean orderly condition acceptable to the Architect/Engineer.

1.11 ELECTRICAL WORK FOR MECHANICAL SYSTEMS

- A. Factory installed starters, controllers, and control equipment mounted in manufactured mechanical equipment necessary for mechanical equipment operation shall be furnished under Division 23.
- B. Power wiring for motors and installation of starters shall be under Division 26 Electrical.
- C. Temperature, humidity, pressure and similar controls essential to the operation of mechanical systems, and wiring and conduit thereof, including interlock wiring, shall be under Division 23 of specifications, installed in accordance with requirements of Division 26.
- D. Motors shall be furnished under Division 23 of capacity required to operate equipment specified, but shall not be less than that specified.
- E. Furnish and install all low voltage (120V and under) temperature control wiring for equipment provided under this division.
- F. Provide conduit when required for control wiring.

1.12 MOTORS

- A. All motors shall be furnished and installed under Division 23 and shall be wired under Division 26 Electrical.

- B. All motors shall be built in accordance with the current applicable IEEE, ASA, and NEMA standards. All general purpose motors shall be open drip-proof machines for installation indoors and/or in protected locations. Totally enclosed fan cooled (TEFC) motors shall be used in all areas of exposure to weather or other environmental contamination. Motors shall be rated explosion proof when located in hazardous atmospheres. Type II weather protected motors may be used in lieu of TEFC motors on roof mounted fan units and similar equipment.
- C. Unless indicated otherwise, motors shall be NEMA Design B with a service factor of 1.15 with total temperature rise of 90 degrees C. (resistance measured) in 40 degrees C. ambient when powered from the system voltage feeding the motor. TEFC motors shall have a service factor of 1.00 with total temperature rise of 80 degrees C. in the above conditions. Motors located in areas exceeding 40 degrees C. ambient shall be factory rated for the ambient temperature of the motor environment. Single phase motors shall generally be NEMA Design N split phase induction motors with built-in thermal protectors. Single phase motors connected on loads requiring high starting torque shall be capacitor-start induction motors. Single phase motors of 1/10 HP or less may be shaded pole induction motors.
- D. If the Contractor proposes to furnish motors varying in horsepower and/or characteristics from those specified, he shall first inform the Architect/Engineer of the change and shall then coordinate the change and shall pay all additional charges in connection with the change.
- E. All motors supplied on this project three (3) HP and larger shall have a power factor not less than 85 percent under rated load conditions. Power factor of less than 85 percent shall be corrected to at least 90 percent under rated load conditions. Power factor corrective devices, installed to comply with this Code, shall be switched with the utilization equipment.
- F. All motors supplied on this project shall be energy efficient. All efficiency testing and labeling shall be performed in accordance with the NEMA Standard MG 1-12.54 and IEEE 112 Test Standard, Method B. Minimum efficiencies shall conform to the following listing:

Motor HP	Efficiency (%)
3/4	80.0
1	82.5
1-1/2	84.0
2	85.5
3	87.5
5	87.5
7-1/2	89.5
10	89.5
15	91.0
20	91.7

1.13 QUIET OPERATION AND VIBRATION

- A. All equipment provided under this section shall operate under all conditions of load free of objectionable sound and vibration. Sound and vibration conditions considered objectionable shall be corrected in an approved manner.
- B. Vibration and sound control shall be by means of approved vibration eliminators or sound attenuators in a manner as specified and as recommended by the manufacturer.

1.14 EQUIPMENT IDENTIFICATION

- A. Each unit shall be identified by its system number and other appropriate designation by stenciling in letters of approved size and wording. Equipment requiring identification shall include: supply and exhaust fans, air conditioning and heating machinery and apparatus, pumps, piping, control cabinets, and other equipment units as may be directed by the Architect/Engineer.

1.15 CLEANING AND ADJUSTMENTS

- A. Upon completion of the work, Contractor shall clean and lubricate fans, motors, and other running equipment and apparatus which he has installed and make certain such apparatus and mechanisms are in proper working order and ready to test.
- B. Scratched or damaged painting shall be touched up as necessary to return the painting to "new" condition and appearance.
- C. All piping and equipment shall be thoroughly blown out under pressure and cleared of all foreign matter, wasting air, gas or water through temporary connections as long as necessary to thoroughly clean system before system is placed in operation. Use every precaution to prevent pipe compound, scale, dirt, welding and other objectionable matter from getting into the piping system and equipment.
- D. During blow out period, baskets from strainers shall be removed, traps and control valves, etc., shall be by-passed.
- E. All cleaning shall be done prior to any sterilization, pressure testing, flow balancing or equipment adjustment procedures.
- F. During construction protect all piping and equipment from damage and dirt. Cap the open ends of all piping and equipment.

1.16 DEMOLITION

- A. Demolition shall be as shown on drawings or specified.
- B. Schedule all demolition work with Owner to cause minimum downtime of any building service or function. No extra cost to the contract will be allowed for

overtime work unless specifically authorized in advance by representative of Owner in writing.

- C. During demolition and construction protect from damage all existing equipment and services that are to remain. Repair or replace any damage to existing facilities at no extra cost to the contract.
- D. Remove with care and deliver to a location designated by representative of the Owner all items designated to remain the property of the Owner.
- E. Drawings are diagrammatic and shown only major obstructions; coordinate with other trades for removal or relocation of pipes; conduits, hangers, etc. in path of work.
- F. No columns, beams, joists, building foundations or any other structural building component shall be cut, drilled or disturbed in any way. Conflicts shall immediately be brought to the attention of the Architect/Engineer. Contractor shall not proceed until instructed in writing by the Architect/Engineer if conflicts between mechanical work and structural elements occur.

1.17 CONNECTIONS TO EXISTING WORK

- A. Plan installation of new work and connections to existing work to insure minimum interference with regular operation of existing facilities.
- B. Submit to the Owner for approval, a schedule of necessary temporary shut-downs of existing services. All shutdowns shall be made at such times as will not interfere with regular operating of existing facilities and only after written approval of the Owner.
- C. To insure continuous operation, make necessary temporary connections between new and existing work.
- D. Connect new work to existing work in neat and approved manner. Restore existing work disturbed to original condition.

1.18 WATERPROOFING

- A. Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as approved by the Owner before the work is done.
- B. Provide all necessary sleeves, caulking and flashing required to make openings absolutely watertight. Waterproof flashing materials shall be compatible with base materials.

1.19 TESTS

- A. Contractor shall make all tests required to establish the adequacy, quality, safety, completed status and satisfactory operation of all systems to the satisfaction of the Architect/Engineer. Provide all instruments, labor and services necessary to conduct tests.

1.20 INSTRUCTIONS

- A. Fully instruct Owner's personnel in the care and operation of mechanical systems and furnish a letter to the Architect/Engineer advising the particular person who has received such instruction.

1.21 WARRANTY

- A. Equipment shall be started, tested, adjusted, and placed in satisfactory operating condition. Furnish a letter addressed to the Architect/Engineer advising that the completed systems have been installed in accordance with the Plans and Specifications and that they are in proper operating condition. The Owner shall receive a written warranty covering all defects in workmanship and material for a period of one year from date of final acceptance. Any defects appearing within this one year period shall be repaired without additional cost to the Owner.

1.22 ACCEPTANCE

- A. Before requesting final inspection:
 - 1. Complete all work required. If any items are held in abeyance as incomplete for final inspection, list such items together with explanation for delay.
 - 2. Submit statement that equipment is properly installed, adjusted, fully lubricated and operation is satisfactory.
 - 3. Certify in writing to the Architect/Engineer that the Owner's representative has been instructed as to the care and operation of the system and that catalog service and maintenance information has been turned over to the Architect/Engineer.
 - 4. Submit copy of written guarantee.
 - 5. Submit copy of other data as may be outlined in these specifications.
- B. Copies of the above data shall be submitted to the Architect/Engineer prior to requesting final inspection.

1.23 FACILITY STARTUP BROCHURE

- A. At the completion of work, Contractor shall provide startup instruction in accordance with Division 01, "Closeout" and shall submit a bound brochure containing the following:
 - 1. Shop Drawings
 - 2. Operating and Maintenance Manuals
 - a. Submittal data stating equipment size and selected options for each piece of equipment requiring maintenance.
 - b. Manufacturer's operation manuals and maintenance manuals for each piece of equipment requiring maintenance, except equipment not furnished as part of the project. Required routine maintenance actions shall be clearly identified.
 - c. Name and address of at least one service agency.
 - d. HVAC controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field-determined setpoints shall be permanently recorded on control drawings at control devices or, for digital control systems, in system programming instructions.
 - e. A narrative of how each system is intended to operate, including recommended setpoints.
 - 3. Control Wiring and Piping Diagrams
 - 4. Operating Instructions
 - 5. Copy of Guarantee
 - 6. Certificate of Instruction of Owner's Representative
 - 7. Certificate of Job Completion
 - 8. Record Documents
- B. Where projects are of sufficient size to make a single brochure impractical, several brochures shall be prepared by trade and As-Built Drawings may be submitted as a separate item.
- C. Brochure shall be indexed and divided for reasonable clarity.
- D. Brochure shall be turned over to the Architect/Engineer for review and approval. The contractor shall make modifications to the brochure as deemed necessary for

compliance and clarity, by the Architect/Engineer, and re-submit the final brochure to the Architect/Engineer to be forwarded to the Owner.

END OF SECTION 23 00 00

SECTION 23 05 29 - HVAC SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. This section is Division 23 Basic Mechanical Materials and Methods section, and is part of each Division 23 section making reference to supports and anchors specified herein.

1.2 DESCRIPTION OF WORK:

- A. Extent of supports and anchors required by this section is indicated on drawings and/or specified in other Division 23 sections.
- B. Types of supports and anchors specified in this section include the following:
 - 1. Horizontal-Piping Hangers and Supports.
 - 2. Hanger-Rod Attachments.
 - 3. Building Attachments.
 - 4. Saddles and Shields.
 - 5. Miscellaneous Materials.
 - 6. Anchors.
 - 7. Equipment Supports.
- C. Supports and anchors furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 23 sections.

1.3 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. Code Compliance: Comply with Florida Building Code pertaining to product materials and installation of supports and anchors.

2. UL and FM Compliance: Provide products which are UL-listed and FM approved.
3. MSS Standard Compliance:
 - a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
 - b. Select and apply pipe hangers and supports, complying with MSS SP-69.
 - c. Fabricate and install pipe hangers and supports, complying with MSS SP-89.
 - d. Terminology used in this section is defined in MSS SP-90.

1.4 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.

PART 2 - PRODUCTS

2.1 HORIZONTAL-PIPING HANGERS AND SUPPORTS:

- A. General: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper-piping systems.
- B. Adjustable Steel Clevis Hangers: MSS Type 1.
- C. Steel Double Bolt Pipe Clamps: MSS Type 3.
- D. Steel Pipe Clamps: MSS Type 4.
- E. Pipe Hangers: MSS Type 5.
- F. Split Pipe Rings: MSS Type 11.
- G. Clips: MSS Type 26.

- H. Pipe Saddle Supports: MSS Type 36, including steel pipe base-support and cast-iron floor flange.
- I. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base-support and cast-iron floor flange.

2.2 HANGER ROD ATTACHMENTS:

- A. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.
- B. Steel Turnbuckles: MSS Type 13.

2.3 BUILDING ATTACHMENTS:

- A. General: Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper-piping systems.
- B. Concrete Inserts: MSS Type 18.
- C. Top Beam C-Clamps: MSS Type 19.
- D. Side Beam or Channel Clamps: MSS Type 20.
- E. Center Beam Clamps: MSS Type 21.
- F. Steel Brackets: One of the following for indicated loading:
 - 1. Light Duty: MSS Type 31.
 - 2. Medium Duty: MSS Type 32.
 - 3. Heavy Duty: MSS Type 33.

2.4 SADDLES AND SHIELDS:

- A. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

- B. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
- C. Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.
- D. Thermal Hanger Shields: Constructed of 360° insert of high density, 100 psi, water-proofed calcium silicate, encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation.
- E. Manufacturer: Subject to compliance with requirements, provide thermal hanger shields of one of the following or approved equivalent:
 - 1. Elcen Metal Products Co.
 - 2. Pipe Shields, Inc.

2.5 MANUFACTURERS OF HANGERS AND SUPPORTS:

- A. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following or approved equivalent:
 - 1. B-Line Systems, Inc.
 - 2. Carpenter and Patterson, Inc.
 - 3. Corner & Lada Co., Inc.
 - 4. Elcen Metal Products Co.
 - 5. Fee & Mason Mfg. Co.; Div. Figgie International.
 - 6. ITT Grinnel Corp.

2.6 MISCELLANEOUS MATERIALS:

- A. Metal Framing: Provide products complying with NEMA STD ML 1.
- B. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A36.
- C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PREPARATION:

- A. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct the inadequacies, including (but not limited to) proper placement of inserts, anchors, and other building structural attachments.
- B. Prior to installation of hangers, supports, anchors, and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Architect/Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.

3.3 INSTALLATION OF BUILDING ATTACHMENTS:

- A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install any additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

3.4 INSTALLATION OF HANGERS AND SUPPORTS:

- A. General: Install hangers, supports, clamps, and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

- C. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.
- D. Provisions for movement: Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- E. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- F. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.
- G. Insulated Piping: Comply with the following installation requirements.
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.
 - 2. Shields: Where low-compressive-strength insulation or vapor barriers are indicated on cold or chilled water piping, install coated protective shields.
 - 3. Saddles: Where insulation without vapor barrier is indicated, install protection saddles.

3.5 INSTALLATION OF ANCHORS:

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.
- C. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.6 EQUIPMENT SUPPORTS:

- A. Provide concrete housekeeping bases for all floor-mounted equipment furnished as part of the work of Division 23. Size bases to extend minimum of 4" beyond equipment base in any direction; and 4" above finished floor elevation. Construct of reinforced concrete, roughen floor slab beneath base for bond, and provide steel

rod anchors between floor and base. Locate anchor bolts using equipment manufacturer's templates. Chamfer top and edge corners.

- B. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

3.7 ADJUSTING AND CLEANING:

- A. Hanger Adjustments: Adjust hangers so as to distribute loads equally on attachments.
- B. Supports Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
- C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 05 29

SECTION 23 05 48 – HVAC NOISE AND VIBRATION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. This section is Division 23 Basic Mechanical Materials and Methods section, and is part of each Division 23 section making reference to vibration isolation work specified herein.

1.2 DESCRIPTION OF WORK:

- A. Noise criteria, vibration tolerance, and vibration isolation for HVAC work.

1.3 QUALITY ASSURANCE

- A. Refer to article, QUALITY ASSURANCE in Section 230000, “HVAC Requirements”.
- B. Noise Criteria:
 - 1. Noise levels in all 8 octave bands due to equipment and duct systems shall not exceed the following values. The stated NC levels are "raw" NC levels and do not include room effect. Manufacturer's product data which includes a room attenuation or room effect are not acceptable and must be increased by the room effect.
 - 2. For equipment which has no sound power ratings scheduled on the plans, the contractor shall select equipment such that the foregoing noise criteria, local ordinance noise levels, and OSHA requirements are not exceeded. Selection procedure shall be in accordance with ASHRAE 2015 Applications Handbook, Chapter 48, SOUND AND VIBRATION CONTROL. An average value of 10 dB shall be used as the room attenuating effect, i.e., the difference between sound power level emitted to room and sound pressure level in room.
 - 3. In absence of specified measurement requirements, measure equipment noise levels three feet from equipment and at an elevation of maximum noise generation.
 - 4. Comply with other requirements in these contract documents for sound and noise control, including requirements on the architectural drawings and Specifications Divisions 1 through 20.

- C. Allowable Vibration Tolerances for Rotating, Non-reciprocating Equipment: Not to exceed a self-excited vibration maximum velocity of 0.20-inch per second RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions or measured at equipment mounting feet if bearings are concealed. Measurements for internally isolated fans and motors may be made at the mounting feet.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01340, SAMPLES AND SHOP DRAWINGS.
- B. Manufacturer's Literature and Data:
 - 1. Vibration isolators:
 - a. Floor mountings.
 - b. Hangers.
 - c. Snubbers.
 - d. Thrust restraints.
 - 2. Bases.
 - 3. Acoustical enclosures.
 - 4. Sound attenuators.
- C. Isolator manufacturer shall furnish with submittal load calculations for selection of isolators, including supplemental bases, based on lowest operating speed of equipment supported.
- D. Sound attenuator manufacturer shall furnish with submittal sound attenuating capability of each sound attenuator provided.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
 - 1. HVAC Applications Handbook 2003, Chapter 47, Sound and Vibration Control.
- C. American Society for Testing and Materials (ASTM):

1. A123-89 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 2. A307-90 Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
 3. D2240-86 Rubber Property - Durometer Hardness
- D. Manufacturers Standardization (MSS):
1. SP-58-88 Pipe Hangers and supports-Materials, Design and Manufacture
- E. Occupational Safety and Health Administration (OSHA):
1. Occupational Noise Exposure

PART 2 - PRODUCTS

2.1 GENERAL

- A. Type of sound attenuator, isolator, base, and minimum static deflection shall be as required for each specific equipment application as recommended by isolator or equipment manufacturer but subject to minimum requirements indicated in the schedule on the drawings.
- B. Group 1: Acoustically Sensitive Spaces NC 40
1. Media Rooms
- C. Group 3: Typical Areas NC 45
1. Administrative Offices, Classrooms.

2.2 VIBRATION ISOLATORS

- A. Floor Mountings:
1. Double Deflection Neoprene (Type N): Shall include neoprene covered steel support plated (top and bottom), friction pads, and necessary bolt holes.
 2. Spring Isolators (Type S): Shall be free-standing, laterally stable and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter-to-operating spring height of 1.0 and an additional travel to solid equal to 50 percent of rated deflection.
 3. Spring Isolators with Vertical Limit Stops (Type SP): Similar to spring isolators preceding, except include a vertical limit stop to limit upward travel if weight is removed and also to reduce movement due to wind loads. Provide clearance around restraining bolts to prevent mechanical short circuiting.

4. Pads (Type D), Washers (Type W), and Bushings (Type L): Pads shall be felt, cork, neoprene waffle, neoprene and cork sandwich, neoprene and fiberglass, neoprene and steel waffle, or reinforced duck and neoprene. Washers and bushings shall be reinforced duck and neoprene. Size pads for a maximum load of 50 pounds per square inch.
- B. Hangers: Shall be combination neoprene and springs unless otherwise noted and shall allow for expansion of pipe.
1. Combination Neoprene and Spring (Type H): Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
 2. Spring Position Hanger (Type HP): Similar to combination neoprene and spring hanger except hanger shall hold piping at a fixed elevation during installation and include a secondary adjustment feature to transfer load to spring while maintaining same position.
 3. Neoprene (Type HN): Vibration hanger shall contain a double deflection type neoprene isolation element. Hanger rod shall be separated from contact with hanger bracket by a neoprene grommet.
 4. Spring (Type HS): Vibration hanger shall contain a coiled steel spring in series with a neoprene grommet. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
 5. Hanger supports for piping 2-inches and larger shall have a pointer and scale deflection indicator.
- C. Snubbers: Each spring mounted base shall have a minimum of four all-directional or eight two directional (two per side) seismic snubbers that are double acting. Elastomeric materials shall be shock absorbent neoprene bridge quality bearing pads, maximum 60 durometer, replaceable and have a minimum thickness of 1/4-inch. Air gap between hard and resilient material shall be not less than 1/8-inch nor more than 1/4-inch. Restraints shall be capable of withstanding design load without permanent deformation.
- D. Thrust Restraints (Type THR): Restraints shall provide a spring element contained in a steel frame with neoprene pads at each end attachment. Restraints shall have factory preset thrust and be field adjustable to allow 1/4-inch maximum movement when the fan starts and stops. Restraint assemblies shall include rods, angle brackets and other hardware for field installation.

E. Manufacturer: Subject to compliance with requirements, provide vibration isolators of one of the following or approved equivalent:

1. Vibration Eliminator Co., Inc.
2. Mason Industries

2.3 BASES

- A. Rails (Type R): Design rails with isolator brackets to reduce mounting height of equipment and cradle machines having legs or bases that do not require a complete supplementary base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension but not less than four-inches. Where rails are used with neoprene mounts for small fans or close coupled pumps, extend rails to compensate overhang of housing.
- B. Integral Structural Steel Base (Type B): Design base with isolator brackets to reduce mounting height of equipment which require a complete supplementary rigid base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension, but not less than four-inches.
- C. Inertia Base (Type I): Base shall be a reinforced concrete inertia base. Pour concrete into a welded steel channel frame, incorporating pre-located equipment anchor bolts and pipe sleeves. Level concrete to provide a smooth uniform bearing surface for equipment mounting. Provide grout under uneven supports. Channel depth shall be a minimum of 1/12 of longest dimension of base but not less than six inches. Form shall include 1/2-inch reinforcing bars welded in place on minimum of eight inch centers running both ways in a layer 1-1/2 inches above bottom. Use height saving brackets in all mounting locations. Weight of inertia base shall be equal to or greater than weight of equipment supported to provide a maximum peak-to-peak displacement of 1/16-inch.
- D. Curb Mounted Isolation Base (Type CB): Fabricate from aluminum to fit on top of standard curb with overlap to allow water run-off and have wind and water seals which shall not interfere with spring action. Provide resilient snubbers with 1/4-inch clearance for wind resistance. Top and bottom bearing surfaces shall have sponge type weather seals. Integral spring isolators shall comply with Spring Isolator (Type S) requirements.

2.4 GENERAL ISOLATOR REQUIREMENTS:

- A. Elastomeric isolators shall comply with ASTM D2240 and be oil resistant neoprene with a maximum stiffness of 60 durometer and have a straight-line deflection curve.
- B. Exposure to Weather: Isolators, including springs, exposed to weather shall be hot-dip galvanized after fabrication. Hot-dip zinc coating shall be not less than two ounces per square foot by weight complying with ASTM A123. In addition, provide limit stops to resist wind velocity.

- C. Uniform Loading: Select and locate isolators to produce uniform loading and deflection even when equipment weight is not evenly distributed.
- D. Color code isolator by type and size for easy identification of capacity.

2.5 DUCT SOUND ATTENUATORS

- A. General: Contractor shall furnish and install prefabricated silencers in the air handling system of the sizes and performance shown on schedule and/or on drawings. They shall be the product of a nationally known manufacturer who has engaged in the manufacture and distribution of this type of equipment for at least 5 years. Manufacturer shall, upon request, provide certified test reports from a nationally known qualified independent laboratory corroborating his cataloged performance. Test reports shall be based on a 24" x 24" cross sectional rectangular and/or 24" diameter tubular silencers of each type and model required for this project. Manufacturer shall obtain prior product approval from the architect and/or consulting engineer not less than 10 days before bid date.
- B. Outer casings shall be of not less than 22 gauge galvanized steel construction. All external seams shall be lockformed and filled with mastic, or continuously welded, and shall be airtight up to 10" water gauge pressure differential. Casings should be suitably stiffened to prevent permanent deformation when tested at 10" pressure differential. They shall not vibrate audibly during normal operation of air handling system.
- C. Interior partitions shall be of not less than 24 gauge galvanized steel perforated to remove not more than 18% of the area. Acoustically absorptive filler material made from an inorganic fiber-glass-like material (mineral wool or spun felt) shall be compressed not less than 5% to eliminate voids and prevent settling. Material shall be vermin and moisture proof and impart no odor to the air. Incombustible filler material shall exhibit not more than the following fire hazard classification values when tested in accordance with standard ASTM E84, NFPA 255 or UL-723 test methods:

1. Flamespread	15
2. Fuel Contributed	15
3. Smoke Developed	0
- D. Provide polyethylene bagging for fill. Bagging shall be continuous and air tight and shall isolate the fill from the air stream.
- E. Acoustical ratings shall be determined by the "duct-to-reverberation room" method as recommended in 1960 by the S1W42 Subcommittee of the American Standards Association. Tests shall be run both with and without air flowing through silencer at not less than three different flow rates. All ratings shall be based on test data from a nationally known qualified independent laboratory. Test method shall

eliminate effects due to end reflection, vibration, flanking transmission and standing waves in the reverberant room. Airflow and pressure loss data taken in accordance with AMCA procedures shall be obtained from the same silencer used for acoustic performance tests. Upon request, evidence will be shown of an airflow pressure drop calibration check with an independent laboratory certified by AMCA.

- F. Silencer shall provide the minimum attenuation values indicated on the drawings in terms of dB insertion Loss for models shown on drawings at design air velocities.
- G. The sound power level generated by airflow through silencer in dB re: 10-12 watts (PWL12) shall not exceed the values indicated on the drawings at design flow rates.
- H. Airflow pressure drop performance of silencer shall not exceed values indicated on schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Vibration Isolation:
 - 1. No metal-to-metal contact will be permitted between fixed and floating parts.
 - 2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, (etc.) which rests on vibration isolators, shall be isolated from building structure for first three hangers or supports.
 - 3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension. Bases shall be level throughout length and width. Provide shims to facilitate pipe connections, leveling, and bolting.
 - 4. Provide heat shields where elastomers are subject to temperatures over 100 degrees F.
 - 5. Extend bases for pipe elbow supports at discharge and suction connections at pumps. Pipe elbow supports shall not short circuit pump vibration to structure.
 - 6. Non-rotating equipment such as heat exchangers and converters shall be mounted on isolation units having the same static deflection as the isolation hangers or support of the pipe connected to the equipment.

- B. Inspection and Adjustments: Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.
- C. Duct Sound Attenuators: Install duct sound attenuators in strict conformance with manufacturer's written instructions. Maintain required lengths of straight duct upstream and downstream of the attenuator.

END OF SECTION 23 05 48

SECTION 23 05 53 - HVAC IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. This section is Division 23 Basic Mechanical Materials and Methods section, and is part of each Division 23 section making reference to identification devices specified herein.

1.2 DESCRIPTION OF WORK:

- A. Extent of mechanical identification work required by this section is indicated on drawings and/or specified in other Division 23 sections.
- B. Types of identification devices specified in this section include the following:
 - 1. Painted Identification Materials.
 - 2. Plastic Pipe Markers.
 - 3. Plastic Tape.
 - 4. Valve Tags.
 - 5. Engraved Plastic-Laminate Signs.
 - 6. Plastic Equipment Markers.
 - 7. Plasticized Tags.
- C. Mechanical identification furnished as part of factory-fabricated equipment, is specified as part of equipment assembly in other Division 23 sections.
- D. Refer to Division 26 sections for identification requirements of electrical work; not work of this section.

1.3 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:

1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.4 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide mechanical identification materials of one of the following or approved equivalent:
 1. Allen Systems, Inc.
 2. Brady (W.H.) Co.; Signmark Div.
 3. Industrial Safety Supply Co., Inc.
 4. Seton Name Plate Corp.

2.2 HVAC IDENTIFICATION MATERIALS:

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.3 PAINTED IDENTIFICATION MATERIALS:

- A. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 1-1/4" high letters for duct work and not less than 3/4" high letters for access door signs and similar operational instructions.
- B. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.
- C. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated for piping systems, comply with ANSI A13.1 for colors.

2.4 PLASTIC PIPE MARKERS:

- A. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1.
- B. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125oF (52oC) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
- C. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - 1. Adhesive lap joint in pipe marker overlap.
 - 2. Laminated or bonded application of pipe marker to pipe (or insulation).
 - 3. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".
- D. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.
- E. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.5 PLASTIC TAPE:

- A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
- B. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2-1/2" wide tape for larger pipes.
- C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.6 VALVE TAGS:

- A. Brass Valve Tags: Provide 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.
 - 1. Provide 1-1/2" diameter tags.

2. Fill tag engraving with black enamel.
- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- C. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

2.7 ENGRAVED PLASTIC-LAMINATE SIGNS:

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/8".
- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.8 PLASTIC EQUIPMENT MARKERS:

- A. General: Provide manufacturer's standard laminated plastic, color coded equipment markers. Conform to the following color code:
 1. Green: Cooling equipment and components.
 2. Yellow/Green: Combination cooling and heating equipment and components.
 3. Blue: Equipment and components that do not meet any of the above criteria.
- B. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
 1. Name and plan number.
 2. Equipment service.
 3. Design capacity.
 4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.

- C. Size: Provide approximate 2-1/2" x 4" markers for control devices, dampers, and valves; and 4-1/2" x 6" for equipment.

2.9 PLASTICIZED TAGS:

- A. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matte finish suitable for writing, approximately 3-1/4" x 5-5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.10 LETTERING AND GRAPHICS:

- A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PIPING SYSTEM IDENTIFICATION:

- A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
 - 1. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
 - 2. Stenciled markers, with lettering color complying with ANSI A13.1.
 - 3. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
 - 4. Stenciled markers, black or white for best contrast, wherever continuous color-coded painting of piping is provided.

- B. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
 - 1. Near each valve and control device.
 - 2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - 3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
 - 4. At access doors, manholes, and similar access points which permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
 - 7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

3.3 VALVE IDENTIFICATION:

- A. General: Provide valve tag on every valve, cock, and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, HVAC terminal devices and similar connections.. List each tagged valve in valve schedule for each piping system.
- B. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.
 - 1. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

3.4 HVAC EQUIPMENT IDENTIFICATION:

- A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 - 1. Main control and operating valves.

2. Meters, gages, thermometers, and similar units.
 3. Pumps, compressors, chillers and similar motor-driven units.
 4. Fans, blowers, primary balancing dampers and mixing boxes.
 5. Packaged HVAC central-station and zone-type units.
- B. Optional Sign Types: Where lettering larger than 1" height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.
- C. Lettering Size: Minimum 1/4" high lettering for name of unit where viewing distance is less than 2'-0", 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
- D. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- E. Optional Use of Plasticized Tags: At Installer's option, where equipment to be identified as concealed above acoustical ceiling or similar concealment, plasticized tags may be installed within concealed space to reduce amount of text in exposed sign (outside concealment).

3.5 ADJUSTING AND CLEANING:

- A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
- B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING AND BALANCING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 TESTING AND BALANCING OF HVAC SYSTEMS

- A. Selection: The General Contractor, herein referred to as Contractor, shall procure the services of, and have a contract directly with an independent Test and Balance contractor (Balancer), which specializes in the testing and balancing of heating, ventilating, and air conditioning systems. The Balancer shall test, balance and adjust all water circulating and air moving equipment, air distribution, and exhaust systems, and temperature control equipment and systems as herein specified and shown on the drawings.
- B. The Contractor shall award the test and balance contract to the Balancer as soon as possible to allow them to schedule the work in cooperation with other trades and to meet the completion date. The Contractor shall prepare a critical path schedule, coordinated with all subcontractors, so as to accomplish all tasks required of the Balancer as scheduled herein.
- C. Refer to specific items of work provided by each installer, and outlined in the paragraph entitled, "CONTRACTOR'S RESPONSIBILITIES." Contractor shall cooperate with the Balancer as required during execution of the work under this section.
- D. The Balancer shall inspect all work under the above sections as it relates to work under this section and report in writing to the Contractor and Design Professional any deviations from plans and specifications that will affect the performance of the systems.
- E. Design balance deviation tolerances:
 - 1. All HVAC systems shall be balanced to +/-5% of design. Except as follows:
 - a. Exhaust and supply fans where the design airflow is less than 100 CFM: Balance to between 100% and 110%.
 - b. Air distribution devices where the design is less than 100 CFM: Balance to within +/- 10%.
 - 2. Each form presented in the report shall include a column that shows the amount of deviation from the design values in percent (%).

1.3 BALANCER QUALIFICATIONS

- A. The Balancer shall be a member in good standing with The Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) and shall provide a National Project Certification Performance Guaranty to the Owner. The Balancer must be totally independent, having no affiliation with any contractor, Design Professional, or equipment manufacturer/supplier of HVAC related equipment.
- B. The Balancer shall have a fully staffed office and have been regularly engaged in the testing and balancing of heating, ventilating, and air conditioning systems.
- C. The Balancer shall provide proof that personnel performing work have successfully completed at least five (5) projects of similar size and scope. A complete list of reference projects, including name and phone number of contacts, shall be submitted with the bid.
- D. All instruments used shall be accurately calibrated within six months of balancing and maintained in good working order. If requested, the test shall be conducted in the presence of the Design Professional and/or his representative.

1.4 BALANCER SUBMITTALS

- A. Provide a testing and balancing plan for review within thirty days upon receipt of contract. The plan review should include comments and recommendations on any discrepancies that may hinder balancing. This plan review shall be transmitted directly to the Contractor.
- B. Submit to Contractor, equipment pre-start and start-up forms. After receipt from the contractor of the submittal data, forms will be transmitted by the Balancer to the Mechanical Contractor for use in equipment start-up. The completed forms will be turned over to the Balancer prior to the beginning of the test and balance phase.
- C. Submit agenda of test procedures for each system, describing balancing standards for the testing and balancing of the air conditioning, heating, and ventilating systems for the approval of the Design Professional. This agenda shall include all forms for each system and component, with specified data from the project plans and specifications included on the forms.
- D. The Final Testing and Balance Report, with the Design Professional's letter of acceptance, must be received by the Owner's Project Coordinator prior to substantial completion inspection. Allow no less than 10 days for Design Professional's review. (See also paragraphs 1.6.B and 3.1.B.)
- E. The Final Testing and Balance Report shall indicate any design requirements which were modified after the issuance of the original Construction Documents. Such indication(s) shall include the date on which the requirement was changed and shall reference the particular Contract Document (i.e., Addenda, Change Order,

Construction Change Directive, etc.) which effected the change. (Changes made without Owner's written approval are invalid.)

1.5 BALANCER MEETINGS, INSPECTIONS AND TESTS

- A. Make inspections of the systems during construction for proper installation of balancing devices and general construction as related to HVAC testing and balancing work. The number of inspections will vary with size and complexity of the project, but a minimum of two inspections is required: one at 50% completion of ductwork installation, the second at 80% completion of ductwork installation. A written report of each job visit shall promptly be sent to the Contractor for transmittal to the Design Professional, and shall be included in the Final Test and Balance report.
- B. Perform Final Test and Balance work associated with the HVAC system as described herein.
- C. A minimum of one after-occupancy inspection shall be made within 90 days after the final test and balance. At this time, any minor adjustments shall be made for occupant comfort. Major problems, which will require major readjustments, shall be addressed to the Design Professional prior to any readjustments. Any alterations to the final test and balance report shall be transmitted as a revised report to the Construction Manager for transmittal to the Design Professional.

1.6 BALANCER WARRANTY AND REPORTS

- A. Provide National Project Certification Performance Guarantee. This Performance Guarantee is to be either by NEBB or AABC. Depending on which organization is chosen, the report is not to mention, or include reference to the other organization.
- B. Submit to the Design Professional (A/E) one (1) printed copies and one (1) electronic PDF copy of tabulated reports in neatly organized typed forms (with numbered pages) with AABC or NEBB approved minimum data, within fifteen working days after completion of test. Report will include start-up reports, equipment test data and drawings to coincide with the test report. In addition, all reports shall incorporate a summary page(s) which shall include:
 - 1. General description of project (building type, system type, equipment description, etc.)
 - 2. A descriptive list of all equipment and test results (sorted building by building) which do NOT meet plans and specifications. All equipment and test data NOT listed on the above-mentioned summary page(s) will be considered to perform within design balance deviation tolerances specified in Paragraph 1.2.E.
 - 3. Copies of reduced plan drawings that uniquely identify and cross-reference air devices, VAV boxes, dampers, equipment, etc.

4. Duct pressure test/leakage and Hydrostatic leakage test reports.
5. Building Pressure tables, design and actual.
6. Start-up reports.
7. Inspection reports.

Any report which the Design Professional determines is inaccurate or incomplete shall be returned to for correction, completion, or retesting. Revised reports shall be submitted in their entirety – partial reports will not be accepted. Each revision shall be highlighted and shall indicate the revision date. The cover page shall indicate the date of the first edition and the revision date.

- D. The Owner reserves the right to obtain verification of the test and balance reports. Such verification shall be performed by a second independent contractor. Balancer's reports found to be inaccurate will be disallowed and the Balancer will be required to repeat operations under the supervision of the second independent contractor until accurate reports are completed and agreed upon. The cost of the verification will be borne by the Owner, unless the Balancer's initial report is found to be inaccurate. In such case, the costs of the verification test and balance and all subsequent costs of supervision in order to secure acceptable reports will be borne by the Balancer.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONTRACTOR'S RESPONSIBILITIES

- A. Final testing and balancing of the HVAC systems shall be performed as specified above. It is the responsibility of the Contractor to be completely familiar with all the provisions and responsibilities of the Balancer, and to provide such certification, cooperation, and support required.
- B. The Contractor shall correct or repair all deficiencies noted by the Balancer in a timely manner. The Balancer will notify the Contractor in writing, on a daily basis, of any deficiencies discovered. Contractor will notify the Balancer immediately, in writing, upon completion of the corrections or repairs. If any items certified as having been corrected or repaired are found to remain deficient, the Contractor shall thereafter be responsible for additional costs incurred by the Balancer and the Design Professional, including but not limited to repeated inspections, tests and document reviews, until such items are individually either deemed compliant or accepted in writing by the Owner. The final testing and balancing report will contain no punch list items. All deficiencies will have been corrected prior to submission of the final report. Preliminary reports are not to be submitted to the Owner.

C. The Contractor shall:

1. Allow adequate time in the construction schedule to perform the Testing and Balancing work.
2. Notify the Balancer upon commencement of work related to the HVAC system.
3. Provide required shop drawings and equipment data.
4. Provide test openings as required for testing and balancing HVAC systems.
5. Provide updated job schedule and timely notice prior to scheduled events.
6. Provide test openings and temporary end caps or otherwise seal off ends of ductwork to permit leakage testing prior to installation of diffusers, grilles, and similar devices.
7. Make preliminary tests to establish adequacy, quality, safety, completed status, and satisfactory operation of HVAC systems and components. The systems shall be free of electrical grounds and short circuits.
8. Perform duct leakage tests, in the presence of the Balancer, on all supply, return, outside air make-up, and exhaust air systems.
9. Within the intent of the contract documents, provide, at the request of the Balancer, all equipment, material, supplies, workmen, and supervisions necessary to provide a satisfactory, operating system.
10. During the test and balance period, operate all HVAC equipment as necessary to permit systems to be tested and balanced as fully operating, functional systems.
11. Work harmoniously with the Balancer, providing all courtesies normally extended to professional consultants.
12. Perform all work necessary to make ceiling plenums air-tight and functional.
13. Remove and replace ceilings as necessary to permit test and balance operations.
14. Remove and replace equipment, lights, or other items which obstruct testing and balancing operations. Where equipment, lights, or other items will interfere with future adjustments of the HVAC system, such equipment, lights, or other items shall be relocated by the Contractor, as directed by the Design Professional.

15. Provide completed start-up forms on each piece of equipment.
 16. Replace belts and drives as required for proper balancing. Drives shall be adjusted and aligned by the Contractor to prevent abnormal belt wear and vibration.
 17. Adjust fan speed as required not to exceed RFLA of motor.
 18. Open all manually adjustable dampers and test dampers for smooth, vibration-free operation.
 19. Verify that all controls are installed and operating in accordance with the sequence of operation.
 20. Before requesting final testing and balancing, submit signed statement that HVAC systems are installed, adjusted, fully lubricated, operating satisfactorily, and are ready for use.
- D. Duct Leakage Report: The Contractor shall make all the supply, return, outside air, and exhaust duct systems (limited to 1,500 CFM and greater) operationally airtight, with no more than 2% leakage for duct systems rated at 2" w.c. pressure class, and 1% leakage for systems exceeding 2" w.c. pressure class. Leakage test to be performed by Contractor with all air device openings and fan connections sealed airtight. Test the systems prior to applying any insulation or concealing in soffits or chases. Use a portable fan capable of producing a static pressure equal or greater than the duct test pressure. This fan to have a flow measuring assembly consisting of a straight section of duct with an orifice plate, pressure taps, and a calibrated performance curve for determining leakage rates.
1. Test each section equal to the external static pressure indicated for that fan or air handler with the portable fan assembly. After the fan achieves that steady state design pressure, record the airflow quantity across the orifice and the percent of design airflow. If the test fails, the Contractor shall reseal and retest at no additional cost to the District.
 2. Repair all duct leaks that can be heard or felt, even if the system has passed the leakage test.
 3. Submit duct leakage reports to the Balancer and the Design Professional for their review and approval.

3.2 BALANCER'S RESPONSIBILITIES

- A. Air Balance: The Balancer shall perform the following tests, and balance system in accordance with the following requirements:
1. Record minimum data required by AABC and NEBB forms.

2. Test and adjust fan rpm to design requirements.
 3. Test and record motor full load amperage/voltage and operating amperage/voltage.
 4. Make pitot tube traverse of main supply, return, OA and exhaust ducts and obtain design CFM at fans. The air flow in rectangular duct shall be traversed and measured using the log-Tchebycheff method and round duct shall be measured with the log-Linear method (a.k.a. log-Tchebycheff), no exceptions. Refer to the AABC's 1989 National Standards Manual Chapter 8; NEBB's latest Procedural Standards, Section 10; and ASHRAE's 1997 Fundamentals Handbook Chapter 14.
 5. Test and adjust system for design CFM recirculated air.
 6. Test and adjust system for design CFM outside air.
 7. Test and record system static pressure profile.
 8. Adjust all main supply and return air ducts to proper design CFM.
 9. Adjust all zones to proper design CFM, supply, return, and exhaust.
 10. Provide suggestion/corrective measures pertaining to performance related issues.
 11. Test and adjust each air distribution device to operate within tolerances specified in Paragraph 1.2.E.
 12. Each grille, diffuser, and register shall be identified as to the location, area, and system.
 13. Test and adjust fans to operate within tolerances specified in Paragraph 1.2.E.
 14. Provide a Table in the report that itemizes all the Outside Air Make-up CFM compared to all the Exhaust Air CFM (specified and actual) that is to demonstrate that the building is experiencing a continual positive pressure. There is to be one Table per building.
- B. Size, AK catalog factors of diffusers, grilles, registers, and all tested equipment shall be identified and listed.
- C. Readings and test of diffusers, grilles, and registers shall include required fpm velocity and test resultant velocity, required CFM, and test resultant CFM after adjustments. When direct CFM measuring instruments are used, velocities are not required.

- D. In cooperation with the controls contractor, set adjustments of automatically operated dampers to operate as specified, indicated, and / or noted.
- E. Check all controls for proper calibrations, and list all controls requiring adjustment by control installers.
- F. All diffusers, grilles, and registers shall be adjusted to minimize drafts in all areas.
- G. Witness and record the testing of the ductwork for leakage to insure proper sealing. The Balancer shall randomly select sections of the completed duct system for testing. The sections selected shall not exceed more than 20% of the measured linear footage of supply, return, exhaust, or plenum duct length. All selected ductwork shall be leak tested in accordance with SMACNA. Maximum allowable leakage at any tested section shall not exceed 2% of the total air. If any of the selected duct sections exceed the specific leakage allowance, those sections shall be repaired by the Contractor and retested by the Balancer. If initial testing exceeds specification allowance, testing of all remaining duct ductwork shall be required at the Contractor's expense. All additional costs for duct leak repair and retesting shall be the responsibility of the Contractor.
- H. Advise Contractor in writing of all ductwork that shall be repaired to reduce air leakage. Retest to confirm minimum allowable leakage. The cost of retest of failed systems will be the responsibility of the Contractor.
- I. Record and check the following items at each cooling / heating element:
 - 1. Test and record entering air temperature (DB heating and cooling).
 - 2. Test and record entering air temperatures (WB cooling).
 - 3. Test and record leaving air temperatures (DB heating and cooling).
 - 4. Test and record leaving air temperatures (WB cooling).
 - 5. If test conditions are not within design tolerance, then convert the test conditions to design conditions, or re-test when conditions are closer to design (i.e. opposite season test).
- J. Record the Dry Bulb Temperature in each space and in addition, record a wet bulb temperature at each thermostat or sensor.
- K. Deficiencies: All deficiencies shall be noted by the Balancer in a field report and submitted to Contractor and the Design Professional on a daily basis. All deficiencies will be uniquely numbered and tracked.
- L. Upon correction of deficiencies, the Contractor shall notify the Balancer in writing that the problem is resolved. If any deficiencies are not corrected, the Contractor will be responsible for the cost of additional re-testing.

M. Equipment: All information required as shown, but not limited to, shall be compiled in a neat, orderly, itemized format on 8½" x 11" test forms. The following data shall be submitted to the Contractor, for distribution to the Design Professional and Owner. This data is the minimum required data except where specified standard (i.e. AABC) requires additional data. In addition, any HVAC equipment specified for the project, but not indicated below, is required per AABC form.

N. Rooftop units:

1. Mark number
2. Unit manufacturers and model number
3. Condenser coil - entering and leaving air DB/ F and WB/ F
4. Outside air DB/ F and WB/ F at time of test
5. Voltage, phase, and cycle specified load conditions
6. Total supply air cfm and rpm - specified and actual
7. Return air cfm - specified and actual
8. Outside air cfm - specified and actual
9. Unit static pressure profile, including total fan static
10. Specified total and external static pressure
11. Evaporator coil pressure drop, and entering and leaving temps - specified and actual
12. Evaporator coil - entering and leaving air DB/ F and WB/ F - specified and actual
13. Outside air DB/ F and WB/ F at time of test
14. Voltage, phase, and cycle specified load conditions
14. Hand calculations of the BTUH at test conditions of total cooling, latent cooling and Sensible cooling.
13. Btu per hour when converted to specified load conditions gpm by means of heat transfer test

P. Fans:

1. Mark number

2. Manufacturer and model number
3. Total cfm supply and rpm - specified and actual
4. Static pressure (discharge static - suction static)
5. Full load amperage - specified and actual
6. Voltage, phase, and cycles - specified and actual

Q. Air Devices (grilles, Registers, Diffusers, and Louvers):

1. Mark number
2. Room number
3. CFM - specified and actual
4. Size
5. Effective area
6. Velocity FPM - specified and actual

END OF SECTION 23 05 93

SECTION 23 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Division 23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.2 DESCRIPTION OF WORK:

- A. Extent of mechanical insulation required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of mechanical insulation specified in this section include the following:
 - 1. Piping System Insulation:
 - a. Fiberglass
 - b. Cellular Glass.
 - c. Flexible Unicellular.
 - 2. Duct Work System Insulation:
 - a. Fiberglass.
 - 3. Equipment Insulation:
 - a. Cellular Glass.
- C. Refer to Division 23 section "Supports and Anchors" for protection saddles, protection shields, and thermal hanger shields; not work of this section.
- D. Refer to Division 23 section "Mechanical Identification" for installation of identification devices for piping, ductwork, and equipment; not work of this section.

1.3 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

- B. Installer's Qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this project.
- C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.
- D. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.

1.4 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.
- B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following or approved equivalent:
 - 1. Armstrong World Industries, Inc.
 - 2. CertainTeed Corp.
 - 3. Knauf Fiber Glass GmbH.
 - 4. Manville Products Corp.
 - 5. Owens-Corning Fiberglas Corp.

6. Pittsburgh Corning Corp.
7. Rubatex Corp.

2.2 PIPING INSULATION MATERIALS:

- A. Fiberglass Piping Insulation: ASTM C 547, Class 1.
- B. Cellular Glass Piping Insulation: ASTM C 552, Type II, Class 2.
- C. Flexible Unicellular Piping Insulation: ASTM C 534, Type I.
- D. Jackets for Piping Insulation: ASTM C 921, Type I for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installers option.
- E. Encase pipe fittings insulation with one-piece premolded PVC fitting covers, fastened as per manufacturer's recommendations.
- F. Encase exterior piping insulation and piping insulation in mechanical rooms up to 6 feet above the floor with aluminum jacket. Aluminum jackets shall cover all fittings and valves for 100% coverage. PVC fitting covers are not permissible.
- G. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.
- H. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- I. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.
 1. For indoor applications, use adhesive that has a VOC content of 50 g/L, or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Use adhesive that complies 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," including 2004 Addenda.

2.3 DUCTWORK INSULATION MATERIALS:

- A. Rigid Fiberglass Ductwork Insulation: ASTM C 612, Class 1.
- B. Flexible Fiberglass Ductwork Insulation: ASTM C 553, Type I, Class B-4.
- C. Jackets for Ductwork Insulation: ASTM C 921, Type I.

- D. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.
- E. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L, or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive that complies 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," including 2004 Addenda.

2.4 EQUIPMENT INSULATION MATERIALS:

- A. Cellular Glass Equipment Insulation: ASTM C 552, Type I.
- B. Jacketing Material for Equipment Insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, or metal jacket at Installer's option, except as otherwise indicated.
- C. Equipment Insulation Compounds: Provide adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L, or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesives and sealants that 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," including 2004 Addenda.
- D. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 HVAC PIPING SYSTEM INSULATION:

- A. Insulation Omitted: Omit insulation on hot piping within radiation enclosures or unit cabinets; on cold piping within unit cabinets provided piping is located over drain pan; on heating piping beyond control valve, located within heated space; on condensate piping between steam trap and union; and on unions, flanges, strainers, flexible connections, and expansion joints.
- B. Cold Piping (40°F (4.4°C) to ambient).
 - 1. Application Requirements: Insulate the following cold HVAC piping systems:
 - a. HVAC chilled water supply and return piping.
 - b. Air conditioning condensate drain piping.
 - 2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
 - a. Cellular Glass:
 - b. The insulation thickness in inches, unless otherwise specifically indicated, shall be in accordance with the following table:

TABLE - CELLULAR GLASS PIPING INSULATION THICKNESS

Pipe Size, Inches	Up to 1	1-1/4 to 2	2-1/2 to 4	5 to 6	8 & Up
Chilled Water 1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	
Glycol or Brine	1-1/2	1-1/2	2	2	2

- c. For piping exposed to the outdoor air, increase insulation thickness by 1/2 inch. Provide insulation in 2 layers for 1-1/2 inch thickness or greater.

3.3 DUCTWORK SYSTEM INSULATION:

- A. Insulation Omitted: Do not insulate fibrous glass ductwork, or lined ductwork.
- B. Cold Ductwork (Below Ambient Temperature):
 - 1. Application Requirements: Insulate the following cold ductwork.
 - a. Outdoor air intake ductwork between air entrance and fan inlet or HVAC unit inlet.

- b. HVAC supply ductwork between fan discharge, or HVAC unit discharge, and room terminal outlet.
 - c. Insulate neck and bells of supply diffusers.
 - d. HVAC return ductwork between room terminal inlet and return fan inlet, or HVAC unit inlet; except omit insulation on return ductwork located in return air ceiling plenums.
 - e. HVAC plenums and unit housings not pre-insulated at factory or lined.
2. Insulate each ductwork system specified above with one of the following types and thicknesses of insulation:
- a. Rigid Fiberglass: 2" in machine, fan and equipment rooms, or
 - b. Flexible Fiberglass: 2" thick, application limited to concealed locations.

3.4 EQUIPMENT INSULATION:

A. Cold Equipment (Below Ambient Temperature):

1. Application Requirements: Insulate the following cold equipment:
- a. Cold equipment, including chillers, tanks, valve bodies, strainers and pumps.
 - b. Drip pans under chilled equipment.
 - c. Cold and chilled water pumps.
 - d. Roof drain bodies.
2. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:
- a. Cellular Glass: 3" thick for surfaces above 35°F (2°C) and 4- 1/2" thick for surfaces 35°F (2°C) and lower (cold and chilled water pumps, expansion tanks, and air and solids separators).
 - b. Flexible Unicellular: 1" thick (roof drain bodies and drip pans).

3.5 INSTALLATION OF DUCTWORK INSULATION:

- #### A. General:
- Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

- B. Install insulation materials with smooth and even surfaces.
- C. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- D. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage.
- E. Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated.
- F. Corner Angles: Install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

3.6 INSTALLATION OF EQUIPMENT INSULATION:

- A. General: Install equipment thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.
- B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.
- C. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.
- D. Apply insulation using staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.
- E. Coat insulated surfaces with layer of insulating cement, troweled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.
- F. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2". Apply over vapor barrier where applicable.
- G. Do not insulate handholes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.
- H. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames, and accessories.
- I. Equipment Exposed to Weather: Protect outdoor insulation from weather by installation of weather-barrier mastic protective finish, or jacketing, as recommended by manufacturer.

3.9 PROTECTION AND REPLACEMENT:

- A. Replace damaged insulation which cannot be satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: Insulation installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 23 07 00

SECTION 23 31 13 - DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 00 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

- A. Extent of low and medium pressure ductwork is indicated on drawings and in schedules, and by requirements of this section.
- B. Definition of Pressure Classifications:
 - 1. Low Pressure/Low Velocity: Less than or equal to 2 inch water gauge (WG) positive or negative static pressure and velocities less than 2,500 FPM.
 - 2. Medium Pressure/High Velocity: 2 inch WG to 9 inch water gauge (WG) positive or negative static pressure and velocities greater than 2,500 FPM.
- C. Types of ductwork required for project include the following:
 - 1. Heating supply and return air systems.
 - 2. Air-conditioning supply and return air systems.
 - 3. Fresh air supply systems.
 - 4. Mechanical exhaust systems.
 - 5. Air relief systems.

1.3 QUALITY ASSURANCE:

- A. SMACNA Standards: Comply with SMACNA "Duct Construction Standards", 3rd edition, 2005.
- B. NFPA Compliance: Comply with the following NFPA Standards:
 - 1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.
 - 2. NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors for Commercial Cooking Equipment," Chapter 3, "Duct System," for kitchen hood duct systems, except as indicated otherwise.

1.4 SUBMITTALS:

- A. General: Submit the following in accordance with Conditions of Contract and Division 00 Specification Sections.
- B. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:
 - 1. Sealing Materials.
 - 2. Fire-Stopping Materials.
- C. Duct Fabrication Shop Drawings: Submit dimensioned layouts of ductwork, showing both the accurately scaled ductwork (1/4"=1'-0" minimum on 36x24 sheets) drawings and its relation to space enclosure. Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced. Show locations of smoke detectors. Coordinate with electrical and plumbing contractors and show location of electrical panels and floor drains.
- D. Welding certificates including welding procedures specifications, welding procedures qualifications test records, and welders' qualifications test records complying with requirements specified in Section 230000.
- E. Record drawings including duct systems routing, fittings details, reinforcing, support, and installed accessories and devices, in accordance with Division 23 Section "Basic Mechanical Requirements" and Division 00.
- F. Maintenance data for volume control devices, fire dampers, and smoke dampers, in accordance with Division 23 Section "Basic Mechanical Requirements" and Division 00.

1.5 QUALITY ASSURANCE

- A. NFPA Compliance: Comply with the following NFPA Standards:
 - 1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.
 - 2. NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors for Commercial Cooking Equipment," Chapter 3, "Duct System," for kitchen hood duct systems, except as indicated otherwise.

1.6 DELIVERY, STORAGE, AND HANDLING:

- A. Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.
- B. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

- A. Sheet Metal, General: Provide sheet metal in thicknesses indicated, packaged and marked as specified in ASTM A 700.
- B. Galvanized Sheet Steel: Lock-forming quality, ASTM A 527, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.
- C. Carbon Steel Sheets: ASTM A 366, cold-rolled sheets, commercial quality, with oiled, exposed matte finish.
- D. Stainless Steel: ASTM A 480, Type 316, sheet form, with no. 4 finish on exposed surface for ducts exposed to view; Type 304, sheet form, with no. 1 finish for concealed ducts.
- E. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless steel ducts provide reinforcing of compatible materials.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.
- G. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials, which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains and discolorations, and other imperfections, including those which would impair painting.

2.2 SEALING MATERIALS

- A. Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant complying with FSTT-S-001657, Type I; formulated with a minimum of 75% solids.
- B. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

2.3 FIRE-STOPPING

- A. Fire-Resistant Sealant: Provide one-part elastomeric sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Products: Subject to compliance with requirements, provide one of the following or approved equivalent:
 - 1. "Dow Corning Fire Stop Foam", Dow Corning Corp.
 - 2. "Pensil 851", General Electric Co.
 - 3. "Dow Corning Fire Stop Sealant", Dow Corning Corp.
 - 4. "3M Fire Barrier Caulk CP-25", Electrical products Div./3M
 - 5. "RTV 7403", General Electric Co.
 - 6. "Fyre Putty", Standard Oil Engineered Materials Co.

2.4 RECTANGULAR DUCT FABRICATION

- A. General: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards," Tables 1-3 through 1-19, including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.
 - 1. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
 - 2. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.
- B. Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure classifications:
 - 1. Supply Ducts: +4" water gauge.
 - 2. Return Ducts: -4" water gauge.
 - 3. Outside Air Ducts: -2" water gauge.
 - 4. Relief Ducts: ± 3 " water gauge.
 - 5. Exhaust Ducts: ± 3 " water gauge.

- 6. Transfer Ducts (without fan): ± 1 " water gauge.
- 7. Supply Ducts Downstream of VAV Terminals: $+1$ " water gauge.
- C. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20 gage or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standard."

2.5 RECTANGULAR DUCT FITTINGS

- A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 2005 Edition, Figures 2-1 through 2-10.

2.6 ROUND DUCT FABRICATION

- A. General: "Basic Round Diameter" as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given sized of flat oval duct. Except where interrupted by fittings, provide round and flat oval ducts in lengths not less than 12 feet.
- B. Round Ducts: Provide round supply and return ducts and fittings as indicated with spiral lockseam construction, except for diameters greater than 72 inches. Use longitudinal butt-welded seams. Comply with SMACNA "HVAC Duct Construction Standards," Table 3-2 for galvanized steel gages.

2.7 ROUND AND SUPPLY AND EXHAUST FITTINGS FABRICATION

- A. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figures 3-4 and 3-5 and with metal thicknesses specified for longitudinal seam straight duct.
- B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.
- C. Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter. Unless elbow construction type is indicated, provide elbows meeting the following requirements:
 - 1. Mitered Elbows: Fabricate mitered elbows with welded construction in gages specified below.
 - a. Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA "HVAC Duct Construction Standards," Table 3-1.

- b. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from 2 inches to 10 inches:
 - 3 to 14 inches: 24 gage.
 - 15 to 26 inches: 22 gage.
 - 27 to 50 inches: 20 gage.
 - 52 to 60 inches: 18 gage.
 - 62 to 84 inches: 16 gage.
 - c. 90-degree, 2-piece, mitered elbows: use only for supply systems, or exhaust systems for material handling classes A and B; and only where space restrictions do not permit the use of 1.5 bend radius elbows. Fabricate with a single-thickness turning vanes.
- 2. Round Elbows - 8 Inches and smaller: die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or 2-inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.
- 3. Round Elbows - 9 Through 14 Inches: gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.
- 4. Round Elbows – Larger than 14 inches and all flat oval elbows: Gored elbows, except where space restrictions require a mitered elbow.
- 5. Die-formed elbows for sizes through 8 inches and all pressures: 20 gage with 2-piece welded construction.
- 6. Round gored elbows gages: same as for non-elbow fittings specified above.
- 7. Pleated elbows sizes through 14 inches and pressures through 10 inches: 26 gage.

2.8 DOUBLE-WALL (INSULATED) DUCTS:

- A. Fabricate double-wall insulated ducts with an outer shell, insulation, and an inner liner as specified below. Dimensions indicated on internally insulated ducts are nominal inside dimensions.
 - 1. Thermal Conductivity: 0.27 Btu/square foot/degree F./inch thickness at 75°F mean temperature.

2. Outer Shell: Base outer shell gauge on actual outer shell dimensions. Provide outer shell lengths 2" longer than inner shell and insulation, and in gauges specified for single-wall duct.
3. Insulation: unless otherwise indicated, provide 1-1/2" thick fiberglass insulation. Provide insulation ends where internally insulated duct connects to single-wall duct or noninsulated components. The insulation end shall terminate the insulation and reduce the outer shell diameter to the inner liner diameter.
4. Solid Inner Liner: Construct round and flat oval inner liners with solid sheet metal of the gauges listed below. For flat oval ducts, the diameter indicated in the table below is the "basic round diameter."
 - a. 3 to 8 inches: 28 gauge with standard spiral construction.
 - b. 9 to 42 inches: 28 gauge with single-rib spiral construction.
 - c. 44 to 60 inches: 26 gauge with single-rib spiral construction.
 - d. 62 to 88 inches: 22 gauge with standard spiral construction.
5. Maintain concentricity of liner to outer shell by mechanical means. Protect insulation from discoloration by mechanical means.

2.9 FACTORY-FABRICATED DUCTWORK:

- A. General:
 1. Double-wall ductwork shall be factory-fabricated.
 2. Single wall ductwork, at installer's option, may be factory-fabricated duct and fittings, in lieu of shop-fabricated duct and fittings.
- B. Material: Galvanized sheet steel complying with ANSI/ASTM A 527, lockforming quality, with ANSI/ASTM A 525, G90 zinc coating, mill phosphatized.
- C. Gage: 28 ga. minimum for round and oval ducts and fittings, 4" through 24" diameter.
- D. Elbows: One-piece construction for 90° and 45° elbows 14" and smaller. Provide multiple gore construction for larger diameters with standing seam circumferential joint.
- E. Divided Flow Fittings: 90° tees, constructed with saddle tap spot-welded and bonded to duct fitting body.

- F. Manufacturer: Subject to compliance with requirements, provide factory-fabricated ductwork of one of the following or approved equivalent:

1. United Sheet Metal Div. United McGill Corp.

2.10 FLEXIBLE DUCTS

- A. General: Comply with UL 181, Class 1.
- B. Flexible Ducts - Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing glass fiber (1" thick in conditioned areas, 1-1/2" thick in non-conditioned spaces) insulation around a continuous inner liner.
1. Reinforcement: Steel-wire helix encapsulated in the inner liner.
2. Outer Jacket: Glass-reinforced, silver mylar with a continuous hanging tab, integral fiber glass tape, and nylon hanging cord.
3. Inner Liner: Polyethylene film.
- C. Manufacturer: Subject to compliance with requirements, provide Flexible Duct Connectors of one of the following or approved equivalent:
1. Clevaflex
2. Genflex type
3. Wiremold
4. Flexmaster

PART 3 - EXECUTION

3.1 DUCT INSTALLATION, GENERAL

- A. Flexible duct runs shall be supported every 3 feet with minimum 1/2-inch strap. Maximum permissible sag is 2 inch per foot.
- B. Flexible duct connections shall include three wraps of approved tape and stainless steel draw band. Insulation jacket shall be sealed with three wraps of approved UL 181B tape.
- C. Duct System Pressure Class: Construct and install each duct system for the specific duct pressure classification indicated.
- D. Install ducts with the fewest possible joints.
- E. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.

- F. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.
- G. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct usable space or block access for servicing building and its equipment.
- H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.
- J. Install insulated ducts with 1-inch clearance outside of insulation.
- K. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.
- L. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- M. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- N. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on four sides by at least 1-1/2 inches.

3.2 SEAM AND JOINT SEALING

- A. General: Seal duct seams and joints as follows:
 - 1. Pressure Classifications Greater Than 3 Inches Water Gage: All transverse joints, longitudinal seams, and duct penetrations.
 - 2. Pressure Classification 2 and 3 Inches Water Gage: All transverse joints and longitudinal seams.
 - 3. Pressure Classification Less than 2 Inches Water Gage: Transverse joints only.
 - 4. Seal externally insulated ducts prior to insulation installation.

3.3 HANGING AND SUPPORTING

- A. Install rigid round, rectangular, and flat oval metal duct with support systems indicated in SMACNA "HVAC Duct Construction Standards," Tables 4-1 through 4-3 and Figures 4-1 through 4-8.
- B. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.
- C. Support vertical ducts at a maximum interval of 16 feet and at each floor.
- D. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated.
- E. Install concrete insert prior to placing concrete.
- F. Install powder actuated concrete fasteners after concrete is placed and completely cured.

3.4 CONNECTIONS

- A. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 23 Section "Duct Accessories."
- B. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figures 2-7 and 2-8.
- C. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figures 2-16 through 2-18.
- D. Terminal Units Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figure 2-19.

3.5 DUCT LEAKAGE TEST

- A. Maximum Allowable Leakage: As described specification 230593.3.1.D.
- B. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.
- C. Leakage test shall be witnessed by the Owner at their discretion.

3.6 CLEANING AND PROTECTION:

- A. Clean ductwork internally, unit-by-unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

- B. Strip protective paper from stainless ductwork surfaces, and repair finish wherever it has been damaged.
- C. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

3.7 BALANCING:

- A. Refer to Division 23 section "Testing and Balancing" for air distribution balancing; not work of this section. Make repairs that become apparent during the balancing process.

END OF SECTION 23 31 13

SECTION 23 33 00 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 00 Specification sections, apply to work of this section.
- B. Division 23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.2 DESCRIPTION OF WORK:

- A. Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this section.
- B. Types of ductwork accessories required for project include the following:
 - 1. Dampers.
 - 2. Low pressure manual dampers.
 - 3. Control dampers.
 - 4. Counterbalanced relief dampers.
 - 5. Fire dampers.
 - 6. Turning vanes.
 - 7. Duct hardware.
 - 8. Duct access doors.
 - 9. Flexible connections.
- C. Refer to other Division 23 sections for testing, adjusting, and balancing of ductwork accessories; not work of this section.

1.3 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of ductwork accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Codes and Standards:

1. SMACNA Compliance: Comply with applicable portions of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".
2. Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.
3. UL Compliance: Construct, test, and label fire dampers in accordance with UL Standard 555 "Fire Dampers and Ceiling Dampers".
4. NFPA Compliance: Comply with applicable provisions of NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.

1.4 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction; and installation instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components.
- C. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 00.

PART 2 - PRODUCTS

2.1 DAMPERS:

- A. Low Pressure Manual Dampers: Provide dampers of single blade type or multiblade type, constructed in accordance with SMACNA "HVAC Duct Construction Standards". Provide stand-off brackets that extend the control handles a minimum of 2 inches from the surface of the duct.
- B. Control Dampers: Provide dampers with parallel blades for 2-position control, or opposed blades for modulating control. Construct blades of 16-ga. steel, provide heavy-duty molded self-lubricating nylon bearings, 1/2" diameter steel axles spaced on 9" centers. Construct frame of 2" x 1/2" x 1/8" steel channel for face areas 25 sq. ft. and under; 4" x 1-1/4" x 16-ga. channel for face areas over 25 sq. ft. Provide galvanized steel finish with aluminum touch-up. Provide extensions for all damper operators for volume control dampers located above hard ceilings with no access.
- C. Counterbalanced Relief Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to relieve at indicated static pressure. Construct

blades of 16-ga. aluminum, provide 1/2" diameter ball bearings, 1/2" diameter steel axles spaced on 9" centers. Construct frame of 2" x 1/2" x 1/8" steel channel for face areas 25 sq. ft. and under; 4" x 1-1/4" x 16-ga. channel for face areas over 25 sq. ft. Provide galvanized steel finish on frame with aluminum touch-up.

- D. Manufacturer: Subject to compliance with requirements, provide dampers of one of the following or approved equivalent:
1. Air Balance, Inc.
 2. Airguide Corp.
 3. American Warming & Ventilating, Inc.
 4. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.
 5. Louvers & Dampers, Inc.
 6. Penn Ventilator Co.
 7. Ruskin Mfg. Co.
 8. Greenheck

2.2 FIRE DAMPERS:

- A. Fire Dampers: Provide dynamic fire dampers, of types and sizes indicated. Dampers shall have horizontal or vertical spring closure operation for assured operation under airflow conditions. Construct casings of 11-ga. galvanized steel. Provide fusible link rated at 160 to 165°F (71 to 74°C) unless otherwise indicated. Dampers shall be installed out of the air stream so that there is no restriction imposed upon the flow of air. Provide damper with positive lock in closed position, and with the following additional features:
1. Damper Blade Assembly: Curtain type.
 2. Blade Material: Steel, match casing.
- B. Manufacturer: Subject to compliance with requirements, provide fire and smoke dampers of one of the following or approved equivalent:
1. Air Balance, Inc.
 2. American Warming & Ventilating, Inc.
 3. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.
 4. Louvers and Dampers, Inc.

5. Penn Ventilator Co.
6. Phillips-Aire.
7. Ruskin Mfg. Co.
8. Greenheck

2.3 TURNING VANES:

- A. Manufactured Turning Vanes: Provide turning vanes constructed of 1-1/2" wide curved blades set at 3/4" o.c., supported with bars perpendicular to blades set at 2" o.c., and set into side strips suitable for mounting in ductwork.
- B. Acoustic Turning Vanes: Provide acoustic turning vanes constructed of airfoil shaped aluminum extrusions with perforated faces and fiberglass fill.
- C. Manufacturer: Subject to compliance with requirements, provide turning vanes of one of the following or approved equivalent:
 1. Aero Dyne Co.
 2. Airsan Corp.
 3. Anemostat Products Div.; Dynamics Corp. of America.
 4. Barber-Colman Co.
 5. Duro Dyne Corp.
 6. Environmental Elements Corp.; Subs. Koppers Co., Inc.
 7. Hart & Cooley Mfg. Co.
 8. Register & Grille Mfg. Co., Inc.
 9. Souther, Inc.

2.4 DUCT HARDWARE:

- A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:
 1. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.
 2. Damper regulator:

- a. Locking quadrant type regulators: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork. Provide extensions for all damper operators for volume control dampers located above hard ceilings with no access.
 - b. "Jiffy" type regulators are not acceptable.
- B. Manufacturer: Subject to compliance with requirements, provide duct hardware of one of the following or approved equivalent:
 - 1. Ventfabrics, Inc.
 - 2. Young Regulator Co.

2.5 DUCT ACCESS DOORS:

- A. General: Provide where indicated, duct access doors of size indicated.
- B. Construction: Construct of same or greater gage as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one size hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors.
- C. Manufacturer: Subject to compliance with requirements, provide duct access doors of one of the following or approved equivalent:
 - 1. Air Balance Inc.
 - 2. Duro Dyne Corp.
 - 3. Register & Grille Mfg. Co., Inc.
 - 4. Ruskin Mfg. Co.
 - 5. Ventfabrics, Inc.
 - 6. Zurn Industries, Inc.; Air Systems Div.

2.6 FLEXIBLE CONNECTIONS:

- A. General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.

- B. Manufacturer: Subject to compliance with requirements, provide flexible connections of one of the following or approved equivalent:
 - 1. American/Elgen Co.; Energy Div.
 - 2. Duro Dyne Corp.
 - 3. Flexaust (The) Co.
 - 4. Ventfabrics, Inc.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF DUCTWORK ACCESSORIES:

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Install turning vanes in square or rectangular 90o elbows in supply and exhaust air systems, and elsewhere as indicated.
- C. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter. Install access doors adjacent to all fire dampers to allow maintenance and inspection of each fire damper. Minimum size of access doors shall be 12 inches square.
- D. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.3 ADJUSTING AND CLEANING:

- A. Adjusting: Adjust ductwork accessories for proper settings.
- B. Label access doors in accordance with Division 23 section "Mechanical Identification".
- C. Final positioning of manual dampers is specified in Division 23 section "Testing, Adjusting, and Balancing".

- D. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 33 00

SECTION 23 34 00 - HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. The ceiling-mounted circulation fan is the model scheduled with the capacities indicated. The fan shall be furnished with standard mounting hardware, variable speed control, and an LED light to provide cooling, destratification, and lighting.

B. Summary of Work

1. Installation of the fan, miscellaneous or structural metal work (if required), field electrical wiring, cable, conduit, fuses and disconnect switches, other than those addressed in the installation scope of work, shall be provided by others. Factory installation services shall be available through the manufacturer. Consult the appropriate installation scope of work for information on the available factory installation options, overview of customer and installer responsibilities, and details on installation site requirements.

1.2 RELATED SECTIONS

- A. 21 00 00 Fire Suppression
- B. 23 00 00 Heating, Ventilating, and Air Conditioning (HVAC)
- C. 26 00 00 Electrical

1.3 REFERENCES

- A. Technischer Überwachungsverein (TUV)
- B. National Fire Protection Agency (NFPA)
- C. Underwriters Laboratory (UL)
- D. Canadian Standards Association (CSA)
- E. National Electric Code (NEC)
- F. International Organization for Standardization (ISO)

1.4 SUBMITTALS

- A. Shop Drawings: Drawings detailing product dimensions, weight, and attachment methods
- B. Part 2 Product Data: Specification sheets on the ceiling-mounted fan, specifying electrical and installation requirements, features and benefits, and controller information
- C. Revit Files: Files provided for architectural design
- D. IES Files.
- E. Installation Guide: The manufacturer shall furnish a copy of all operating and maintenance instructions for the fan. All information is subject to change without notice.
- F. Schedule

1.5 QUALITY ASSURANCE

- A. Certifications
 - 1. The fan assembly, as a system (without light kit), shall be TUV-certified and built pursuant to the guidelines set forth by UL standard 507 and CSA standard 22.2 No. 113.
 - 2. The fan (without light kit) shall be compliant with NFPA 13—Standard for the Installation of Sprinkler Systems, NFPA 72—National Fire Alarm and Signaling Code, and NFPA 70-2011—NEC.
 - 3. Controllers shall comply with NEC and UL standards and shall be labeled where required by code.
 - 4. The LED Light Kit shall be compliant to ANSI/UL 1598 and CSA C22.2 No. 250.
- B. Manufacturer Qualifications
 - 1. The fan and any accessories shall be supplied by the manufacturer that has a minimum of ten (10) years of product experience.
 - 2. ISO 9001-certified]
 - 3. The manufacturer shall not be listed on the Air Movement and Control Association International Inc. (AMCA) Certified Ratings Program (CRP) Non-Licensed Products report in the previous 18 months.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver product in original, undamaged packaging with identification labels intact. The fan shall be new, free from defects, and factory tested.
- B. The fan and its components must be stored in a safe, dry location until installation.

1.7 WARRANTY

- A. The Warranty Period for surfaces with enhanced finishes (painted, anodized, etc.) shall be limited to one year. The manufacturer shall replace any products or components defective in material or workmanship for the customer free of charge (including transportation charges within the USA), pursuant to the complete terms and conditions of the manufacturer's Non-Prorated Warranty in accordance to the following schedule:

Item	Period of Coverage
Hub and airfoils	Lifetime (Parts) [†]
Motor, drive, and controller	10 years ^{††}
Light Kit	5 years (Parts)
Labor	1 year ^{††}
Enhanced finishes	1 year ^{†††}

[†] "Lifetime" means a period ending seven (7) years after the manufacturer discontinues manufacturing the product, as such period is defined by the manufacturer, but in no event shall this period be less than 10 years from the date that the Warranty Period commences, as defined above.

^{††} The 10-Year Warranty Period and 1-Year Labor apply to non-residential installations only, and requires purchased installation by a factory-approved, a manufacturer certified installer and the submission of installation documentation by such installer. A 5-Year Warranty Period will apply for proper installations by any other state qualified or licensed electrical contractor. The Warranty is void in its entirety if the product is installed by personnel other than a state qualified or licensed contractor.

^{†††} The 1-year enhanced finishes warranty applies to outdoor installations only.

PART 2 - PRODUCT

2.1 MANUFACTURER

- A. Delta T Corporation, dba Big Ass Fans, PO Box 11307, Lexington, Kentucky 40575. Phone (877) 244-3267. Fax (859) 233-0139. Website: www.bigassfans.com.
- B. Approved equivalent.

2.2 HIGH VOLUME, LOW SPEED FANS

A. Complete Unit

1. Regulatory Requirements: The entire fan assembly (without light kit) shall be TUV-certified and built pursuant to the construction guidelines set forth by UL standard 507 and CSA standard 22.2. No. 113.
2. Sustainability Characteristics: The fan shall be designed to move an effective amount of air for cooling and destratification of conditioned commercial applications over an extended life. The fan components shall be designed specifically for high volume, low speed fans to ensure lower operational noise. Sound levels from the fan operating at maximum speed measured in a laboratory setting shall not exceed 40 dBA. Actual results of sound measurements in the field may vary due to sound reflective surfaces and environmental conditions.
3. Good workmanship shall be evident in all aspects of construction. Field balancing of the airfoils shall not be necessary.

B. Controls

1. The fan controller shall be incorporated into the fan assembly and housed in an enclosure independent of the motor to prevent overheating or electrical interference. The fan controller shall be factory programmed to minimize starting and braking torques and shall be equipped with a simple diagnostic program and an LED light to identify and relay faults in the system.

C. Airfoil System

1. The fan shall be equipped with eight (8) high volume, low speed airfoils of precision extruded, anodized aluminum alloy. Each airfoil shall be of the high-performance Mini-Elipto design. The airfoils shall be connected to the hub and interlocked with eight (8) stainless steel retainers and two (2) sets of stainless steel bolts and lock washers per airfoil.
2. The fan shall be equipped with eight (8) upswept winglets designed to redirect outward airflow downward, thereby enhancing efficiency. The winglets shall be molded of high strength polymer and shall be attached at the tip of each airfoil with a stainless steel screw. The standard color of the winglets shall be silver or black.
3. As an option, the fan shall be equipped with eight (8) plug-style airfoil tips, molded of high strength polymer, in place of the eight (8) upswept winglets. The airfoil tips shall be attached at the tip of each airfoil with a stainless steel screw. The standard color of the airfoil tips shall be black.

D. Motor

1. The motor shall operate from a factory set voltage at one of the following:
 - a. 110–125 VAC, single phase, 50/60Hz
 - b. 200–240 VAC, single phase, 50/60Hz
2. The fan motor shall be a permanent magnet brushless motor rated for continuous operation at maximum speed with the capability of modulating the fan speed from 0–100% without the use of a gearbox or other mechanical means of control. The motor shall be a non-ventilated, heat sink design with the capability of continuous operation in -40°F to 131°F (-40°C to 55°C) ambient condition. The standard color of the motor unit shall be white with silver trim or silver with black trim.
3. The motor shall be rated at one of the following:
 - a. 8-ft fan average power @ max speed = 475 Watts
 - b. 10-ft fan average power @ max speed = 425 Watts
 - c. 12-ft fan average power @ max speed = 350 Watts
 - d. 14-ft fan average power @ max speed = 300 Watts

E. LED Light Kit

1. The fan shall be equipped with a hollow shaft in which electrical wiring can be routed to below the fan. The LED light kit shall operate independently from the fan at an operating voltage of 120–277VAC, 50–60 Hz. The standard color of the LED light kit components shall be white or silver. The manufacturer shall provide a controller to operate the LED light.
2. The LED light kit shall have a standard LED color temperature and lumen of the following:
 - a. 4,000 CCT (5,000 lumens)

F. Mounting System

1. The fan mounting system shall be designed for quick and secure installation from a variety of structural supports. All components in the mounting system shall be of formed metal design using low-carbon steel no less than 3/16" (0.5 cm) thick and containing no critical welds. The mounting system shall be powder coated for appearance and resistance to corrosion. All mounting bolts shall be metric stainless steel or equivalent. No mounting hardware substitutions, including cast aluminum, are acceptable.

2. The fan extension tube shall be a round, extruded aluminum tube. The extension tube shall include a chrome cover plate for access to wiring connections, with forward and reverse controls and a fan status indicator light that is visible from the floor.

G. Hub

1. The fan hub shall be constructed of zinc plated steel for high strength and durability. The hub shall be precision machined to achieve a well-balanced and solid rotating assembly.

H. Safety Cable

1. The fan shall be equipped with a safety cable that provides an additional means of securing the fan assembly to the building structure. The safety cable shall be Ø3/16" (0.5 cm) diameter and fabricated out of 7 x 19 stranded galvanized steel, pre-loaded and tested to 3,200 lbf (13,345 N).
2. Field construction of safety cables is not permitted.

I. Wall Control

1. The fan shall be equipped with a low-voltage wired remote wall control providing control of all fan functions. The wall control shall be capable of mounting to a standard electrical box or directly to a wall surface. The wall control shall include a rotary-style dial for controlling the fan's power and speed and an LED light to identify and relay faults in the system. Communication with the fan drive and controller shall be by a standard, commercially available CAT5 (or higher) Ethernet cable that is field installed and provided by the installer.

J. Fire Control Panel Integration

1. Includes a 10–30 VDC pilot relay for seamless fire control panel integration. The pilot relay can be wired Normally Open or Normally Closed in the field.

K. Guy Wires

1. Guy wires shall be included for installations with extension tubes 4 ft (1.2 m) or longer to limit the potential for lateral movement.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Fan location shall have a typical bar joist or existing I-beam structure from which to mount the fan. Additional mounting options may be available.

- B. Mounting structure shall be able to support weight and operational torque of fan. Consult structural engineer if necessary.
- C. Fan location shall be free from obstacles such as lights, cables, or other building components.
- D. Check fan location for proper electrical requirements. Consult Installation Guide for appropriate circuit requirements.
- E. Each fan requires dedicated branch circuit protection.

3.2 INSTALLATION

- A. The fan and LED light kit shall be installed by a factory-certified installer according to the manufacturer's Installation Guide, which includes acceptable structural dimensions and proper sizing and placement of angle irons for bar joist applications. A structural engineer for installation methods outside the manufacturer's recommendation and a certification, in the form of a stamped print or letter, submitted prior to installation shall be required.
- B. Minimum Distances
 - 1. Airfoils shall be at least 10 ft (3 m) above the floor.
 - 2. Installation area shall be free of obstructions such as lights, cables, sprinklers, or other building structures with the airfoils at least 2 ft (0.61 m) clear of all obstructions.
 - 3. The structure the fan is attached to shall be capable of supporting a torque load of up to 40 ft·lb (54 N·m) of torque.
- C. The fan shall not be located where it shall be continuously subjected to wind gusts or in close proximity to the outputs of HVAC systems or radiant heaters.
- D. The LED light kit shall be installed on a separate circuit from the fan and connected to the lighting grid control, not the fan control.
- E. In buildings equipped with sprinklers, including ESFR sprinklers, fan installation shall comply with all of the following:
 - 1. The maximum fan diameter shall be 14 ft (4.27 m).
 - 2. The HVLS fan shall be centered approximately between four adjacent sprinklers.
 - 3. The vertical clearance from the HVLS fan to the sprinkler deflector shall be a minimum of 3 ft (0.9 m).

4. All HVLS fans shall be interlocked to shut down immediately upon receiving a waterflow signal from the alarm system in accordance with the requirements of NFPA 72—National Fire Alarm and Signaling Code.

END OF SECTION 23 34 00

SECTION 23 36 13 - TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.
- B. Division 23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.2 DESCRIPTION OF WORK:

- A. Extent of terminal unit work is indicated by drawings and schedules, and by requirements of this section.
- B. Types of terminal units required for project include the following:
 - 1. Electric duct heaters
 - 2. Variable air volume terminals
- C. Refer to other Division 23 sections for piping; ductwork; and testing, adjusting and balancing of terminal units; not work of this section.

1.3 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of terminal units, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 SUBMITTALS:

- A. Product Data: Submit manufacturer's specifications for terminal units showing dimensions, capacities, ratings, performance characteristics, gages and finishes of materials, and installation instructions.
 - 1. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, construction details, and field connection details.
 - 2. Maintenance Data: Submit maintenance instructions, including lubrication instructions, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 00.

1.5 DELIVERY, STORAGE AND HANDLING:

- A. Handle terminal units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged terminal units or components; replace with new.
- B. Store terminal units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with manufacturer's rigging and installation instructions for unloading terminal units, and moving them to final location.

PART 2 - PRODUCT

2.1 ELECTRIC DUCT HEATERS:

- A. Electric duct heaters and air handling coils shall be as manufactured by Brasch Manufacturing Company, Inc. Voltage, size, KW, steps and control voltage shall be as scheduled. Three phase heaters shall have balanced phases.
 - 1. Heaters shall be UL Listed for zero clearance and shall meet all NEC requirements.
 - 2. Type: Heaters shall be of the following configuration:
 - a. For Duct MountingAll Slip-in or Flanged
 - b. For Air Handling Unit CoilsAll Slip-in or Flanged
 - c. Multizone Hot Deck CoilsSlip-in Type
 - 3. Open coil heating elements shall be 80% nickel and 20% chromium; steps shall be arranged to prevent stratification when operating at less than full capacity. Elements for draw-through air handling units shall be derated to 35 watts per square inch; blow-through air handling coils and variable volume reheat coils shall be derated to 25 watts per square inch.
 - 4. Element terminals shall be stainless steel; insulators and bracket bushings shall be nonporous ceramic and securely positioned. Terminals shall be machine crimped to elements.
 - 5. Elements for Finned Tubular heaters shall have steel fins brazed to copper plated sheath. Element wire shall be 80/20 Nichrome. Elements shall be protected against corrosion by a high-temperature aluminum coating.
 - 6. Terminals shall be sealed with silicone rubber to protect against moisture.
 - 7. Frame shall be constructed of heavy gauge galvanized steel with galvanized steel brackets, stiffening ribs and gussets spot-welded to the frame.

8. Terminal box shall be spot welded construction with solid, hinged cover, totally enclosed, without louvers or grilles per the UL Standard.
 9. Recessed terminal box to be provided when coils are installed in ducts with internal insulation or obstruction greater than 1".
 10. Direction of airflow: heaters shall be interchangeable for horizontal left or right or vertical up airflow except when position sensitive mercury contactors or SCRs are built-in. In these cases, airflow direction shall be as scheduled.
 11. Safety devices: a disc-type automatic reset thermal cutout shall be furnished for primary overtemperature protection. For secondary protection, a sufficient number of replaceable thermal cutouts in the power lines shall de-energize elements if the primary cutout fails. All safety devices shall be serviceable through the terminal box without removing the heater from the duct.
 12. Wiring diagrams: a unique wiring diagram shall be furnished for each heater. Diagram shall include recommended supply wire gauges per NEC and fuse sizes. Typical wiring diagrams are not acceptable.
 13. Built-in components shall include safety interlocking disconnect switch, disconnecting break magnetic contactors, transformer with primary fusing per UL, pressure-type airflow switch set at .05" WC, supplementary circuit fuses per NEC (one set of fuses per 48 amp circuit), and separate load and control terminal blocks to accept conductors as shown on the electrical plan.
 14. Manufacturer to provide two-year limited warranty for heating elements; other components and accessories to be warranted for one year.
- B. Manufacturer: Subject to compliance with requirements, provide electric duct heaters of one the following or approved equivalent:
1. Brasch
 2. Indeeco
 3. Qmark
 4. Dell-Heatrix

2.2 VARIABLE AIR VOLUME TERMINALS:

- A. Furnish and install single duct terminals of sizes and capacities (CFM) indicated on the drawings. Terminals shall be constructed of not less than 24 gauge zinc-coated steel, mechanically assembled and sealed to form an air-tight casing; maximum air-leakage of 2% at 3" w.g. Spot-welded casings are not acceptable. Interior walls of

the terminal casing shall be insulated with 1" foil-faced fiberglass for R=4.3, rated for a maximum air velocity of 4500 fpm. Insulation must meet all requirements of UL 181 and State of Florida Energy Compliance Code. Raw edges exposed to the airstream shall be coated and sealed. Sound power data shall be submitted with no corrections or noise reduction factors applied.

- B. Terminal air control valve shall be foil-faced construction, creating an effective radiated sound barrier. Insulation shall be as specified for terminal casing. The control blade of the air valve shall be 16-gauge, designed to operate through a 45° arc. Multi-blade dampers and single blade volume controllers (operating through 90°) are not acceptable. The control blade shall be bolted or welded to a continuous shaft which rotates in self-lubricating nylon bearings. Blade shall close against a closed-cell gasket seat; it shall be preloaded to insure a tight seal. Blade shall not deflect at inlet pressures up to 6" w.g. Elliptical or oval dampers are not an acceptable substitution.
- C. Terminal shall be furnished with factory mounted controls as shown in the Sequence of Controls.
- D. Pressure differential reset controller shall maintain set point (CFM) within 5%, regardless of system pressure change. CFM limiting devices are not acceptable. The reset controller shall constantly monitor thermostat input, air flow (CFM), and system static and total pressures in a manner as to minimize under or over-controlling in relation to the space temperature requirements. The reset controller shall be capable of field adjustment of minimum and maximum CFM settings without the use of tools. Flow curve for field balancing shall be affixed to terminal casing. Differential flow taps and factory-set CFM shall be provided if so noted at terminal schedule on the drawings. Controller shall maintain pressure independence to as low as .03" w.g. Averaging sensor shall be mounted in the inlet of the terminal and shall provide a minimum of one air pickup point for each 2-1/2" of inlet diameter. Single-point differential sensors are not acceptable.
- E. Provide electric resistance heaters of the size and type indicated on the drawings. Electric heaters shall be factory mounted and shall be controlled from the variable air volume terminal factory control box. Provide necessary relays and safety devices. Provide pressure switch connected to the flow sensor ports and set for the velocity pressure related to the minimum heating air flow value. Pressure switches on the outlets of the terminals are not acceptable.
- F. Noise Criteria: Unless otherwise indicated, the following noise criteria comprise the basis upon which the selected terminal units shall be rated:
 - 1. All sound power level decibels shall be referenced to 10 to the minus 12 watts.
 - 2. Room outlet NC sound pressure levels specified for terminal unit shall be based on 10dB room absorption.

3. Room radiated NC sound pressure levels specified for terminal unit shall be based on 10 dB 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 NC30 as a result of radiated or discharged noise from any terminal unit.
- G. Manufacturer: Subject to compliance with requirements, provide variable air volume terminals of one the following or approved equivalent:
1. Envirotec
 2. Metal Aire
 3. Price
 4. Titus
 5. Trane

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Examine areas and conditions under which terminal units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF VARIABLE AIR VOLUME TERMINALS:

- A. General: Install variable air volume terminals as indicated, and in accordance with manufacturer's installation instructions.
- B. Locate variable air volume terminals as indicated. Coordinate the location of the terminal unit with the building structure, ductwork, lighting fixtures, and other obstructions to ensure that conflicts are avoided.
- C. Install ductwork as indicated.

3.3 ELECTRICAL WIRING:

- A. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
- B. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed

with equipment start-up until wiring installation is acceptable to equipment installer.

3.4 ADJUSTING AND CLEANING:

- A. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.

END OF SECTION 23 36 13

SECTION 23 37 13 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 00 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this section.
- B. Types of air outlets and inlets required for project include the following:
 - 1. Ceiling air diffusers.
 - 2. Louvers.
- C. Refer to other Division 23 sections for ductwork and duct accessories required in conjunction with air outlets and inlets; not work of this section.
- D. Refer to other Division 23 sections for balancing of air outlets and inlets; not work of this section.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".
 - 2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".
 - 3. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.4 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:
 - 1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
 - 2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
 - 3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.
- B. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 CEILING AIR DIFFUSERS:

- A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity, and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- C. Ceiling Compatibility: Provide 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 ceiling air diffuser.

- D. Diffuser Dampers: Fire Damper: Combination adjustable opposed blade damper and fusible link fire damper with UL approved link and assembly designed to meet requirements of NFPA 90A.
- E. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on diffuser schedule.
- F. Manufacturer: Subject to compliance with requirements, provide diffusers of one of the following or approved equivalent:
 - 1. Anemostat Products Div.; Dynamics Corp. of America.
 - 2. Carnes Co.; Div. of Wehr Corp.
 - 3. Krueger Mfg. Co.
 - 4. Metalaire
 - 5. Titus Products Div.; Philips Industries, Inc.
 - 6. Price Industries

2.2 LOUVERS:

- A. General: Except as otherwise indicated, provide manufacturer's standard louvers where shown; of size, shape, capacity, and type indicated; constructed of materials and components as indicated, and as required for complete installation.,
- B. Performance: Provide louvers that have minimum free area, and maximum pressure drop for each type as listed in manufacturer's current data, complying with louver schedule.
- C. Substrate Compatibility: Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate which will contain each type of louver.
- D. Materials: Construct of aluminum extrusions, ASTM B 221, Alloy 6063-T52. Weld units or use stainless steel fasteners.
- E. Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.

- F. Manufacturer: Subject to compliance with requirements, provide louvers of one of the following or approved equivalent:
 - 1. Greenheck Fan Company
 - 2. Pottorff
 - 3. Ruskin

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

- A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions.
- B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.
- C. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling modules.

3.3 SPARE PARTS:

- A. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that require them.

END OF SECTION 23 37 13

SECTION 26 05 00 - ELECTRICAL METHODS AND 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.
- B. Furnish and install all electrical wiring, systems, equipment and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, cable, panelboards, etc., and arrangement for specified items in general are shown on drawings.
- C. All ampacities herein specified or indicated on the drawings are based on copper conductors, with the conduit and raceways accordingly sized. Aluminum conductors are not permitted.

1.2 MINIMUM REQUIREMENTS

- A. References to the National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL), Florida Building Code, and National Fire Protection Association (NFPA) are a minimum installation requirement standard. Design drawings and other specification sections shall govern in those instances where requirements are greater than those specified in NEC.
- B. The rules and regulations of the Federal, State, local, civil authorities and utility companies in force at the time of execution of the contract shall become a part of this specification. In addition, the following codes and standards shall apply:
 - 1. Florida Building Code (FBC) 5th Edition (2014): This code includes The 2014 FBC Building, Mechanical, Plumbing, Fuel Gas and Energy Conservation Volumes. Further, see "Referenced Standards" in the FBC, Building Chapter 35; FBC, Plumbing Chapter 14; FBC, Mechanical Chapter 15; FBC, Fuel Gas Chapter 8, FBC, Energy Conservation Chapter 5.) (Effective June 30, 2015)
 - 2. 5th Edition of the Florida Fire Prevention Code (FFPC): (This code also includes the Florida versions of NFPA 1 and NFPA 101.) (Effective December 31, 2014)
 - 3. 2011 National Electrical Code
- C. No work shall be done unless the Superintendent of the Contractor is on the job site. Work shall be properly protected, all rubbish removed promptly, and exposed work shall be carefully cleaned prior to final acceptance.

- D. The term "provide" shall include labor, materials, and equipment necessary to furnish and install, complete and operable, the item or system indicated.
- E. In decisions arising from discrepancies, interpretation of Drawings and Specifications, substitutes, and other pertinent matters, the decision of the Owner's representative's approval shall be final.

1.3 SPECIFICATIONS AND DRAWINGS

- A. Plans show location of fixtures and equipment and are intended to depict the general intent of the work in scope, layout and quality of workmanship. They are not intended to show in minute detail every or all accessories intended for the purpose of executing the work, but it is understood that such details are a part of this work.
- B. Where Drawings and Specifications conflict, it shall be the responsibility of this Contractor to bring such conflict to the attention of the Architect/Engineer for clarification. In general, the Architectural Drawings shall take precedence over the Mechanical Drawings with reference to building construction. All changes from the Drawings necessary to make the work conform with the building as constructed and to fit the work of other trades or to conform to the rules of authorities having jurisdiction, shall be made by the Contractor at his own expense.
- C. Keep a record of the locations of concealed work and of any field changes in Contract Drawings and Specifications for each trade and, upon completion of the job, supply "As-Built" Drawings and Specifications showing in pencil on sepia reproduces, any deviations from the original Drawings, indicating in the Specifications each manufacturer's name underlined or inserted whose product was used on the job. These Drawings shall indicate dimensions of buried utility lines from building walls. One set of sepia reproduces of the original tracings will be furnished upon request for this purpose.

1.4 STANDARDS

- A. All material and equipment shall be listed, labeled or certified by Underwriters Laboratories, Inc., where such standards have been established. Equipment and material which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.
- B. Definitions:

1. Listed: Equipment is "listed" if of a kind mentioned in a list which:
 - a. Is published by a nationally recognized laboratory which makes periodic inspection of production of such equipment.
 - b. States that such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.
2. Labeled: Equipment is labeled if:
 - a. It embodies a valid label, symbol, or other identifying mark of a nationally recognized testing laboratory such as Underwriters Laboratories, Inc.
 - b. The laboratory makes periodic inspections of the production of such equipment.
 - c. The labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.
3. Certified: Equipment is "certified" if:
 - a. Equipment has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
 - b. Production is periodically inspected by a nationally recognized testing laboratory.
 - c. It bears a label, tag, or other record of certification.
4. Nationally recognized Testing Laboratory: A testing laboratory which is approved, in accordance with OSHA regulations, by the Secretary of Labor.

1.5 QUALIFICATIONS (PRODUCTS AND SERVICES)

- A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least five years, unless otherwise noted elsewhere in the specifications or on the drawings.
- B. Product Qualification:
 1. Manufacturer's product shall have been in satisfactory operation on three installations of similar size and type, as this project, for approximately three years.

2. The Owner reserves the right to require the contractor to submit a list of installations where the products have been in operation before approval of said products.
- C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.6 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts should be available. Items not meeting this requirement, but which otherwise meet technical specifications, and merits of which can be established through reliable test reports or physical examination of representative samples, will be considered.
- B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
 1. All components of an assembled unit need not be products of the same manufacturer, however, the assembled unit shall be the responsibility of a single manufacturer and warranted as such.
 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
 3. Components shall be compatible with each other and with the total assembly for the intended service.
 4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. All factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.

1.7 EQUIPMENT REQUIREMENTS

- A. Equipment voltage ratings shall be in accordance with the requirements indicated on the drawings or as specified.
- B. Prior to bid, written approval shall be obtained by the Contractor for any equipment that differs from those specified on the drawings and specifications.

The Contractor shall be prepared to submit samples of the equipment when requested at no cost to the Architect/Engineer.

1. The Contractor shall furnish drawings showing all installation details, shop drawings, technical data and other pertinent information as required to determine that the equipment is equivalent in quality and function to the equipment specified.
 2. Approval by the Architect/Engineer of the equal equipment does not relieve the Contractor of the responsibility of furnishing and installing the equipment at no additional cost to the Owner.
 3. Any other items required for the satisfactory installation of the equal equipment shall be furnished and installed at no additional cost to the Owner. This includes but shall not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and correlation with other work, subject to the jurisdiction and approval of the Architect/Engineer.
- C. Catalogue numbers, where given, are intended to give a basis for design, quality and function. Any other incidental equipment needed for a complete and functional installation shall be provided at no additional cost.

1.8 EQUIPMENT PROTECTION

- A. Equipment and material shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain.
- B. During installation, equipment, controls, controllers, circuit protective devices, etc., shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing, operating and painting.
- C. Damaged equipment shall be, as determined by the Architect/Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
- D. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
- E. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.9 WORK PERFORMANCE

- A. Arrange, phase and perform work to assure electrical service for other buildings at all times.

- B. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions.
- C. Coordinate location of equipment and conduit with other trades to minimize interferences.
- D. Obtain and pay for all required installation inspections and deliver certificates approving installations to the Owner unless directed otherwise.

1.10 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. Equipment location shall be as close as practical to locations shown on the drawings. Where architectural features govern location of work, refer to architectural drawings.
- B. Working spaces shall not be less than specified in the National Electrical Code for all voltages specified.
- C. Inaccessible Equipment:
 - 1. Where the Owner/Architect/Engineer determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled as directed at no additional cost to the Owner.
 - 2. "Conveniently accessibility" 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.
- D. Equipment and Material:
 - 1. New equipment and material shall be installed, unless otherwise specified.
 - 2. Equipment and material shall be designed to assure satisfactory operation and operating life for environmental conditions where being installed. NEC and other code requirements shall apply to the installation in areas requiring special protection such as explosion-proof, watertight and weatherproof construction.
- E. Utility Services:
 - 1. Determine utility connection requirements and include in the base bid all costs to the Owner for utility service. Provide all required materials and labor for any power service shutdown and turn on for phasing.

2. Include all costs for temporary service, temporary routing of service or any other requirements of a temporary nature associated with the utility service.

F. Continuity of Service:

1. No service shall be interrupted or changed without permission from the Architect and the Owner. Written permission shall be obtained before any work is started.
2. When interruption of services is required, all persons concerned shall be notified and a prearranged time agreed upon.

G. Concrete Work:

1. Provide all cast-in-place concrete shown on the documents unless noted otherwise. Concrete work shall conform to all applicable Division 02 and 03 specification sections.
2. Provide all anchor bolts, metal shapes and templates required to be cast in concrete or used to form concrete for support of electrical equipment.

1.11 EQUIPMENT IDENTIFICATION

- A. In addition to the requirements of the National Electrical Code, install an identification nameplate which will clearly indicate information required for use and maintenance of items such as switchboard, panelboards, cabinets, safety switches, separately enclosed circuit breakers, motor starters, communications systems cabinets, control devices and other significant equipment.
- B. Nameplates shall be laminated white phenolic resin with a black core with engraved lettering, a minimum of 3/16-inch high. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions. Hand written marker is not acceptable.

1.12 SUBMITTALS

- A. The Architect/Engineer's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site. Submittals shall be made for all equipment and systems as indicated in the respective specification section.
- B. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Architect/Engineer to ascertain that the proposed equipment and materials comply with specification and drawing

requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.

- C. Submittals for individual systems and equipment assemblies which 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 for approval. Submittals shall be submitted for all applicable products and materials specified in each individual section of these specifications.
- D. Make submittals for the equipment and materials in accordance with the following:
 - 1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
 - 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 - 3. The submittals shall include the following:
 - a. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required. Provide any additional information specifically requested in the individual specification section or on the drawings.
 - 4. Electronic PDF submittal files shall be named utilizing the specification number followed by a sequential number for the submittal made under the given specification number followed by "r#" if it is a resubmittal, and then followed by a brief description of the submitted item.
 - a. The description shall indicate the actual item submitted, shall not be general in nature, and does not have to be that of the specification section heading.
 - b. Using the example, "230519-4r2 Differential Pressure Gauge"; 230519 – Meters and Gauges is the relevant specification, the "4" shows it was the fourth submittal for specification section 230519 02, "r2" shows it was the second resubmittal, and the description indicates what item is submitted.
 - c. Each specification item shall be submitted in a separate PDF file. PDF files with multiple specification items will be returned without review.
 - d. Each file shall have sufficient space allowance for the Architects and Engineer's review stamp(s).

- e. Each file shall have the Construction Managers review stamp(s) and indicate information required by specification 260500.1.12.F.
- E. Shop drawings on paper 11”X17” or smaller in size shall be submitted in a tabbed and indexed three ring binder. The binder shall not exceed 11-5/8” height. Partial submittals are unacceptable. The index shall indicate the related specification section number.
- F. The Construction manager will certify that all Division 26 shop drawings are in conformance with the plans and specifications. Deviations from the plans and specifications shall be noted, and the specific area of the deviation clouded and in contrasting color (green) with a complete explanation for the reasons for the deviation.
- G. Carefully examine all shop drawings and mark-up as necessary before submitting to the Architect/Engineer for review. The consultant will only consider shop drawings bearing the contractor’s stamp of approval.
- H. The engineer’s review shall not relieve the contractor from the responsibility for deviations from drawings and specifications. The engineer’s review shall be construed to apply only to general arrangement and shall not relieve the contractor from the responsibility for the correctness of details and dimensions and provision of the correct equipment.
- I. The contractor shall retain copies of all reviewed shop drawings on the job site for reference.
- J. In addition to the requirement of SUBMITTALS, the Owner reserves the right to request the manufacturer to arrange for the Owner's representative(s) to see typical active systems in operation, when there has been no prior experience with the manufacturer or the type of equipment being submitted.
- K. Operation and Maintenance Manuals:
 - 1. Maintenance manuals shall be complete and shall be furnished in a loose leaf binder or in the manufacturer's standard binder. Information shall be sufficient to enable a qualified technician to perform normal first line maintenance and repair. A parts list shall be included which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
 - 2. Operation manuals shall be clear and concise and shall describe, in detail, the information required to properly operate the equipment specified. The manuals shall include complete catalog cuts and as-built wiring diagrams.
 - 3. Operation and maintenance manuals shall be submitted for approval prior to final close-out.

1.13 CUTTING, PATCHING, EXCAVATION, BACKFILL, AND LAYOUT

- A. Provide openings and excavation required for the installation of the electrical work. Patch work and backfill as required. Finished work shall match the existing adjoining work.
- B. Verify all conditions affecting the work to be performed under this contract.
- C. Carefully verify measurements at the site, determine the exact location of chases and openings required. Provide sleeves, inserts, supports, concrete work, and hangers as required. No columns, beams, joists, building foundations nor any other structural building component shall be cut, drilled or disturbed in any way without prior approval. Conflicts shall immediately be brought to the attention of the Architect/Engineer.
- D. All excavation on sites containing existing buildings and existing services, shall be done with hand shovel to avoid damage to existing services. Where hand shovel is not practical extreme caution shall be taken when performing excavation. The contractor will be responsible for locating any existing utilities and adjusting manhole and handhole locations and conduit routing as necessary. Any damage incurred by the Contractor shall be repaired by the Contractor in a manner approved by the Architect/Engineer at no cost to the Owner and with no extension of time limitation.

1.14 EXPERIENCE

- A. The Contractor performing this work shall be a licensed, reputable firm, regularly performing the type of work incorporated in this project and who also maintains, as part of the firm, a service department with qualified personnel who regularly perform this type of work. The Contractor shall, upon request, show evidence of at least two jobs of similar character and size installed within the preceding two years.

1.15 ELECTRICAL WORK FOR MECHANICAL SYSTEMS

- A. Factory installed starters, controllers, and control equipment mounted in manufactured mechanical equipment necessary for mechanical equipment operation shall be furnished under Division 23 Mechanical.
- B. Power wiring for motors and installation of starters not provided integral with equipment shall be under Division 26 Electrical.
- C. Temperature, humidity, pressure and similar controls essential to the operation of mechanical systems, and wiring and conduit thereof, including interlock wiring, shall be under Division 23 of Specifications, installed in accordance with requirements of Division 26.

- D. Motors shall be furnished under Division 23 Mechanical of capacity required to operate equipment specified, but shall not be less than that specified.
- E. All low voltage (120V and under) temperature control wiring for Division 15 equipment shall be provided under by Division 23.
- F. Division 23 shall provide conduit when required for control wiring, installed in accordance with Division 26 requirements.

1.16 MOTORS

- A. All motors shall be furnished and installed under Division 15 Mechanical and shall be wired under Division 16 Electrical.

1.17 REMOVAL OF RUBBISH

- A. Contractor shall keep premises free from accumulations of waste material or rubbish caused by his employees or work. At completion of work, he shall remove all his tools, scaffolding, surplus materials, and rubbish from building and site. He shall leave premises and his work in a clean orderly condition acceptable to the Architect/Engineer.

1.18 QUIET OPERATION AND VIBRATION

- A. All equipment provided under this section shall operate under all conditions of load free of objectionable sound and vibration. Sound and vibration conditions considered objectionable shall be corrected in an approved manner.
- B. Vibration and sound control shall be by means of approved vibration eliminators or sound attenuators in a manner as specified and as recommended by the manufacturer.

1.19 CLEANING AND ADJUSTMENTS

- A. Upon completion of the work, Contractor shall clean and re-lamp all light fixtures, clean and identify all equipment, adjust and test all equipment and apparatus which he has installed and make certain such apparatus and mechanisms are in proper working order and ready to test.
- B. During construction protect all conduit and equipment from damage and dirt. Cap the open ends of all conduit and equipment.

1.20 STORAGE OF MATERIALS

- A. All materials stored on site shall be properly protected from injury or deterioration. Materials shall not be stored in contact with ground or floor.

- B. Do not remove manufacturer's packing materials until ready to install. Materials showing signs of corrosion, improper handling or storage shall be replaced at no cost to the Owner.
- C. Provide continuous protection for all equipment already installed.

1.21 WATERPROOFING

- A. Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as approved by the Owner before the work is done.
- B. Provide all necessary sleeves, caulking and flashing required to make openings absolutely watertight. Waterproof flashing materials shall be compatible with base materials.

1.22 TESTS

- A. Contractor shall make all tests required to establish the adequacy, quality, safety, completed status and satisfactory operation of all systems to the satisfaction of the Architect/Engineer. Provide all instruments, labor and services necessary to conduct tests.
- B. All conductors for major feeders and services (400 amps and up) shall be megged to test insulation and connection integrity prior to permanent energization.

1.23 INSTRUCTIONS

- A. Fully instruct Owner's personnel in the care and operation of electrical systems, including all communications, sound and fire alarm systems and furnish a letter to the Architect/Engineer advising the particular person(s) who have received such instruction.

1.24 WARRANTY

- A. Equipment shall be started, tested, adjusted, and placed in satisfactory operating condition. Furnish a letter addressed to the Architect/Engineer advising that the completed systems have been installed in accordance with the Plans and Specifications and that they are in proper operating condition. The Owner shall receive a written warranty covering all defects in workmanship and material for a minimum period of one year from date of substantial completion. Any defects appearing within this year period shall be repaired or replaced without additional cost to the Owner. Refer to individual specification sections for additional warranty requirements. Longer, extended warranty periods shall apply where specified in any individual specification section.

1.25 ACCEPTANCE

- A. Before requesting final inspection:

1. Complete all work required. If any items are held in abeyance as incomplete for final inspection, list such items together with explanation for delay.
 2. Submit statement that equipment is properly installed, adjusted, tested and operation is satisfactory.
 3. Submit copy of other data as may be outlined in these specifications.
- B. Copies of the above data shall be submitted to the Architect/Engineer prior to requesting final inspection.

1.26 SINGULAR NUMBER

- A. Where any device or part of equipment is referred to in these specifications in the singular number (such as "the switch"), such reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.27 EXISTING ELECTRICAL SYSTEMS

- A. Existing power, lighting and low voltage systems that are to remain shall be protected during construction and shall remain in operation while the building is occupied. Any and all areas that are occupied during construction shall have operational systems, including fire alarm, intercom/paging, and voice/data cabling infrastructure system. Any damage to any existing systems shall be repaired or replaced as necessary to place it back into acceptable operational condition. All electrical systems are deemed to be operational and in satisfactory condition. At the contractors option, the following systems may be fully tested prior to any work in the building and any existing problems or trouble on these systems shall be reported to the Owner in writing. Any new problems discovered during or after construction that are not documented will be the responsibility of the Contractor to correct at no additional cost to the Owner.

1. Any TV or AV systems
2. Fire Alarm System
3. Sound and intercom systems
4. Voice and Data Network system, including any existing fiber backbone
5. Security systems

1.28 PHASING OF POWER AND SYSTEMS

- A. Existing power, voice/data network system, fire alarm, and security systems may need to be phased. These systems shall be operational when the building is

occupied. All costs for labor and materials necessary to accomplish any required phasing shall be included. Any downtime required for the transition from the old system to the new system shall be coordinated with the Owner and approved by the Owner. Costs for any necessary overtime and use of the Owner's custodial staff after hours shall be included in the bid.

- B. Provide all required temporary power, control and low voltage wiring as necessary to maintain operation of these systems during phasing of the construction.
- C. Provide temporary power connections for all required temporary HVAC equipment, including existing equipment being used for temporary use, and for all rental HVAC equipment.

1.29 MULTIWIRE BRANCH CIRCUITS

- A. All multi-wire branch circuits shall comply with Article 210.4 of the 2011 National Electrical Code. Provide all required handle ties where applicable multi-wire branch circuits are indicated on the drawings.

END OF SECTION 26 05 00

SECTION 26 05 19 - WIRES AND CABLES

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. This section is a Division-26 Basic Electrical Materials and Methods section, and is part of each Division-23 and -26 section making reference to electrical wires and cables specified herein.

1.2 DESCRIPTION OF WORK

- A. Extent of electrical wire and cable work is indicated by drawings and schedules.
- B. Types of electrical wire, cable, and connectors specified in this section include the following:
 - 1. Copper conductors.
 - 2. Fixture wires.
 - 3. Flexible cords and cables.
 - 4. Wirenut connectors.
- C. Applications of electrical wire, cable, and connectors required for project are as follows:
 - 1. For motor-branch circuits.
 - 2. For power distribution circuits
 - 3. For lighting circuits
 - 4. For appliance and equipment circuits

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical wire and cable products of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical wiring and cabling work similar to that required for this project.

- C. NEC Compliance: Comply with NEC requirements as applicable to construction, installation and color coding of electrical wires and cables.
- D. UL Compliance: Comply with applicable requirements of UL Std 83, "Thermoplastic-Insulated Wires and Cables", and Std 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors".
- E. UL Compliance: Provide wiring/cabling and connector products which are UL-listed and labeled.
- F. NEMA/ICEA Compliance: Comply with NEMA/ICEA Std Pub/ No.'s WC 5, "Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy", and WC-30, "Color Coding of Wires and Cables", pertaining to electrical power type wires and cables.
- G. IEEE Compliance: Comply with applicable requirements of IEEE Stds 82, "Test Procedures for Impulse Voltage Tests on Insulated Conductors", and Std 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to wiring systems.
- H. ASTM Compliance: Comply with applicable requirements of ASTM B1, 2, 3, 8, and D-753. Provide copper conductors with conductivity of not less than 98% at 20oC (68oF).

PART 2 - PRODUCTS

2.1 AVAILABLE MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
 - 1. Wire and Cable:
 - a. American Wire and Cable Co.
 - b. Anaconda-Ericsson Inc; Wire and Cable Div.
 - c. Belden Div; Cooper Industries
 - 2. Connectors:
 - a. AMP, Inc.
 - b. Appleton Electric Co.
 - c. Burndy Corporation
 - d. Thomas and Betts Corp.

2.2 WIRES, CABLES, AND CONNECTORS

- A. General: Provide electrical wires, cables, and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, for a complete installation, and for application indicated. Except as otherwise indicated, provide copper conductors with conductivity of not less than 98% at 20oC (68oF).
- B. Building Wires: Provide factory-fabricated wires of sizes, ampacity ratings, and materials for applications and services indicated. Where not indicated, provide proper wire selection as determined by Installer to comply with project's installation requirements, NEC and NEMA standards. Select from the following UL types, those wires with construction features which fulfill project requirements:
 - 1. Type THHN, THWN, THHW, XHHW, THHN/THWN: Unless otherwise indicated, all conductors for dry locations requiring a conductor temperature rating 75oC (167oF) or less. Insulation shall be flame retardant, moisture and heat resistant, thermoplastic. Conductor shall be annealed copper.
 - 2. Type THWN, THHW, XHHW, THHN/THWN: Unless otherwise indicated, all conductors for wet or dry locations requiring a conductor temperature rating of 75oC (167oF) or less. Insulation shall be flame retardant, moisture and heat resistant thermoplastic. Conductor shall be annealed copper.
 - 3. Type THHN, THHW, XHHW: Unless otherwise indicated, all conductors for dry locations requiring a conductor temperature rating of 90oC (194oF) or less. Insulation shall be flame retardant, moisture and heat resistant thermoplastic. Conductor shall be annealed copper.
 - 4. Type XHHW-2: Unless otherwise indicated, all conductors for wet locations requiring a conductor temperature rating of 90oC (194oF) or less. Insulation shall be flame retardant, moisture and heat resistant thermoplastic. Conductor shall be annealed copper.
 - 5. Conductors for use at 600 volts or below shall be 600 volt rated. Wire No. 12 and smaller may be solid or stranded and wire No. 10 and larger shall be stranded only. Stranded conductors shall terminate in crimp type lugs.
 - 6. Motor circuit branch wiring and associated control wiring: Provide type THHN insulation in dry and damp locations. Provide type THHW insulation in wet locations. All motor wiring to be stranded copper.
 - 7. Wiring in fluorescent fixture channels: Provide conductors with a 90°C temperature rating, type THHN or TFFN insulation.

- C. Cables: Provide UL-type factory-fabricated cables of sizes, ampacity ratings, and materials and jacketing/sheathing as indicated for services indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements, NEC and NEMA standards.
- D. Connectors:
 - 1. General: Provide UL-type factory-fabricated, metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Where not indicated, provide proper selection as determined by Installer to comply with project's installation requirements, NEC and NEMA standards. Select from the following, those types, classes, kinds, and styles of connectors to fulfill project requirements:
 - a. Type: Pressure.
 - b. Class: Insulated.
 - c. Kind: Copper (for Cu to Cu connection).
 - d. Style: Butt connection.
 - e. Style: Elbow connection.
 - f. Style: Combined "T" and straight connection.
 - g. Style: "T" connection.
 - h. Style: Split-bolt parallel connection.
 - I. Style: Tap connection.
 - j. Style: Pigtail connection.
 - k. Style: Wirenut connection.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRES AND CABLES

- A. General: Install electrical cables, wires, and wiring connectors as indicated, in compliance with applicable requirements of NEC, NEMA, UI, and NECA's "Standard of Installation", and in accordance with recognized industry practices.
- B. Coordinate wire/cable installation work including electrical raceway and equipment installation work, as necessary to properly interface installation of wires/cables with other work.

- C. Pull conductors simultaneously where more than one conductor is being installed in the same raceway.
- D. Use pulling compound or lubricant, where necessary; compound used must not deteriorate conductor or insulation.
- E. Use pulling means including, fish tape, cable, rope and basket weave or wire/cable grips which will not damage cables or raceway. Any cable damaged during installation shall be completely replaced.
- F. Keep conductor splices to minimum. No joints shall be made in conductor except at junction boxes, outlet boxes or splice boxes. Newly installed conductors shall not be spliced unless specifically noted on the drawings. Splices shall not be permitted underground.
- G. Install splices and tapes which possess equivalent-or-better mechanical strength and insulation ratings than conductors being spliced.
- H. Use splice and tap connectors which are compatible with conductor material.
- I. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A and B.
- J. At least eight inches (8") of slack wire shall be left in every outlet box whether it be in use, or left for future use.
- K. Color code wiring as follows:
 - 1. 120/208 volt, 3 phase, 4 wire: phase A-black, phase B-red, phase C-blue, neutral-white; ground conductor-green.
 - 2. 277/480 volt, 3 phase, 4 wire: phase A-brown, phase B-orange, phase C-yellow, neutral-gray; ground conductor-green.
- L. Wire and cable boxes and reels shall bear the date of manufacture and must not bear dates by more than one year preceeding contract date.
- M. Minimum conductor sizes, except as specifically identified on the drawings, shall be as follows:
 - 1. No. 12 - Branch circuits of any kind, except as specified otherwise below.
 - 2. No. 14 - Signal systems, fire alarm system, unless specifically noted otherwise.

3. No. 10 - Exit light circuits, emergency circuits, security lighting, and exterior light circuits.

3.2 FIELD QUALITY CONTROL

- A. Prior to energization, test wires and cables for electrical continuity and for short-circuits.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING

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. Division-26 Basic Electrical Materials and Methods section apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of grounding work is indicated by drawings and schedules.
- B. Types of grounding specified in this section include the following:
 - 1. Solid grounding
- C. Applications of grounding work in this section including the following:
 - 1. Underground metal water piping
 - 2. Metal building frames
 - 3. Grounding electrodes
 - 4. Grounding rods
 - 5. Service equipment
 - 6. Enclosures
 - 7. Equipment
 - 8. Communications systems

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors, terminals and fittings, of types and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, ground rods and plate electrodes, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer: Qualified with at least 3 years of successful installation experience on projects with electrical grounding work similar to that required for project.

- C. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of electrical grounding systems, associated equipment and wiring. Provide grounding products which are UL-listed and labeled.
- D. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467 and 869 pertaining to electrical grounding and bonding.
- E. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical grounding.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on grounding systems and accessories.
- B. Shop Drawings: Submit layout drawings of grounding systems and accessories including, but not limited to, ground wiring, copper braid and bus, ground rods, and plate electrodes.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering grounding products which may be incorporated in the work include, but not limited to, the following:
 - 1. Burndy Corp.
 - 2. Crouse-Hinds Co.
 - 3. Electrical Components Div.; Gould Inc.
 - 4. Thomas and Betts Corp.

2.2 GROUNDING SYSTEMS

- A. Materials and Components:
 - 1. General: Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, terminals (solderless lugs), grounding rods/electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type unit meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.

- B. Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC.
- C. Ground Rods: Solid copper or copper clad, minimum 3/4" dia. x 10'. Provide longer rods if necessary for required resistivity.
- D. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Installer must examine areas and conditions under which electrical grounding connections are to be made and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF ELECTRICAL GROUNDING

- A. General: Install electrical grounding systems where shown, in accordance with applicable portions of NEC, with NECA's "Standard of Installation", and in accordance with recognized industry practices, to ensure that products comply with requirements and serve intended functions.
- B. Coordinate with other electrical work as necessary to interface installation of electrical grounding system work with other work.
- C. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity.
- D. All ground connections to water service entrance shall be installed to be exposed and visible for inspection at all times. Insulation shall not be installed over ground connections.
- E. A water pipe, by itself, is not an adequate grounding electrode and must be supplemented by dual grounding electrodes, a minimum of 8 feet apart, and effectively bonded together. The supplemental ground shall be per Code with the "Footing type electrode" installed as required by current National Electrical Code. Provide a new service entrance grounding electrode system including bonding to metallic cold water pipe, structural steel and building re-bar, if available.
- F. All ground connections shall be made on surfaces which have been cleaned of all paint, dirt, oil, etc., so that connections are bare metal to bare metal contact. All ground connections shall be tight and shall be made with U.L. listed grounding devices, fittings, bushings, etc.

- G. Duplex receptacles of any amperage shall be grounding type and shall have a separate grounding contact. A separate jumper shall be installed between the grounding terminal on the device and the metallic box. The Contractor may provide U.L. listed self-grounding receptacles in lieu of providing the separate jumper.
- H. Single and duplex receptacles shall have all grounded metal mechanically bonded together. Pressure bonding only is not acceptable.
- I. In all cases where flexible metallic conduit, nonmetallic rigid conduit or liquid tight flexible conduit is used, a green wire ground conductor shall be used to provide ground continuity between the equipment of device and the conduit raceway system.
- J. Provide a separate green wire ground conductor for each branch circuit originating from each panelboard. This ground shall be used to ground the device or load fed, and shall be bonded to components of the raceway system, such as junction boxes, starter or disconnect switch enclosures, equipment cases, etc. The green wire ground conductor shall terminate in the panelboard at the green wire ground bus. Ground conductors for branch circuits shall be of size indicated in NEC, except minimum size ground conductor shall be No. 12 AWG.
- K. Each branch feeder originating at the switchboard(s) shall have a green wire ground conductor originating at the ground bus in the switchboard and terminating at the green wire ground bus in the panelboard. This green wire ground conductor shall be of size indicated in NEC except in no instance smaller than No. 8 AWG.
- L. The green wire ground conductor is in addition to the neutral conductor and in no case shall the neutral conductor serve as the grounding means.
- M. Multiple conductors in a single lug not permitted. Each grounding conductor shall terminate in its own terminal lug.
- N. Grounding connections shall be tested and certified by the installer. The service entrance ground and each building ground shall have a maximum of 5 ohms resistance to ground. Supplemental grounding shall be provided if necessary.

END OF SECTION 26 05 26

SECTION 26 05 29 - SUPPORTING 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.
- B. This section is a Division-26 Basic Electrical Materials and Methods section, and is a part of each Division-26 section making reference to electrical supporting devices specified herein.

1.2 DESCRIPTION OF WORK

- A. Extent of supports, anchors, sleeves, and seals is indicated by drawings and schedules and/or specified in other Division-16 sections.
- B. Types of supports, anchors, sleeves, and seals specified in this section include the following:
 - 1. Clevis hangers
 - 2. C-clamps
 - 3. I-beam clamps
 - 4. One-hole conduit straps
 - 5. Round steel rods
 - 6. Lead expansion anchors
 - 7. Toggle bolts
 - 8. Wall and floor seals
- C. Supports, anchors, sleeves, and seals furnished as part of factory-fabricated equipment, are specified as part of that equipment assembly in other Division-26 sections.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of supporting devices, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years.

- B. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of electrical supporting devices.

PART 2 - PRODUCTS

2.1 MANUFACTURED SUPPORTING DEVICES

- A. General: Provide supporting devices which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation; and as herein specified. Where more than one type of supporting device meets indicated requirements, selection is Installer's option.
- B. Supports: Provide supporting devices of types, sizes, and materials indicated; and having the following construction features:
 - 1. Clevis Hangers: For supporting 2" rigid metal conduit; galvanized steel; with 1/2" dia. hole for round steel rod; approximately 54 pounds per 100 units.
 - 2. Reducing Couplings: Steel rod reducing coupling, 1/2" x 5/8"; black steel; approximately 16 pounds per 100 units.
 - 3. C-Clamps: Black malleable iron; 1/2" rod size; approximately 70 pounds per 100 units.
 - 4. I-Beam Clamps: Black steel, 1-1/4" x 3/16" stock; 3/8" cross bolt; flange width 2"; approximately 52 pounds per 100 units.
 - 5. One-Hole Conduit Straps: For supporting 3/4" rigid metal conduit; galvanized steel; approximately 7 pounds per 100 units.
 - 6. Hexagon Nuts: For 1/2" rod size; galvanized steel; approximately 4 pounds per 100 units.
 - 7. Round Steel Rod: Black steel; 1/2" dia.; approximately 67 pounds per 100 feet.
 - 8. Offset Conduit Clamps: For supporting 2" rigid metal conduit; black steel; approximately 200 pounds per 100 units.
- C. Anchors: Provide anchors of types, sizes, and materials indicated, with the following construction features:
 - 1. Lead Expansion Anchors: 1/2", approximately 38 pounds per 100 units.
 - 2. Toggle Bolts: Springhead; 3/16" x 4", approximately 5 pounds per 100 units.

- D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering anchors which may be incorporated in the work include, but are not limited to, the following:
1. Abbeon Cal Inc.
 2. Ackerman Johnson Fastening Systems, Inc.
 3. Elcen Metal Products Co.
 4. Ideal Industries, Inc.
 5. Joslyn Mfg. and Supply Co.
 6. McGraw Edison Co.
 7. Rawlplug Co., Inc.
 8. Star Expansion Co.
 9. Expansion Bolt Co.
- E. Sleeves and Seals: Provide sleeves and seals, of types, sizes, and materials indicated, with the following construction features:
1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sizes indicated; suitable for sealing around conduit, pipe, or buting passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.
- F. U-Channel Strut Systems: Provide U-channel strut system for supporting electrical equipment, 12-gage hot-dip galvanized steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with standard finish, and with the following fittings which mate and match U-channel.
1. Fixture hangers
 2. Channel hangers
 3. Thinwall conduit clamps
 4. Rigid conduit clamps
 5. Conduit hangers
 6. U-bolts

- G. Available Manufacturers: Subject to compliance with requirements, manufacturers offering channel systems which may be incorporated in the work include, but are not limited to, the following:
1. Greenfield Mfg. Co.; Inc.
 2. Midland-Ross Corp.
 3. OZ/Gedney Div.; General Signal Corp.
 4. Power-Strut Div.; Van Huffel Tube Corp.
 5. Unistrut Div.; GTE Products Corp.
- H. Pipe Sleeves: Provide pipe sleeves of one of the following:
1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal: 3" and smaller, 20-gage; 4" to 6", 16-gage; over 6", 14-gage.
 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
 3. Iron Pipe: Fabricate from cast-iron or ductile-iron pipe; remove burrs.
 4. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
- I. Sleeve Seals: Provide sleeves for piping which penetrates foundation walls below grade, or exterior walls. Calk between sleeve and pipe with non-toxic, UL-classified calking material to ensure watertight seal.

PART 3 - EXECUTION

3.1 INSTALLATION OF SUPPORTING DEVICES

- A. Install hangers, anchors, sleeves, and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.
- B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work. Coordinate support locations with other structural and mechanical trades. Supports shall not be attached to mechanical or electrical piping, conduit, ductwork, ceiling grid system or any other non-structural member.
- C. Install hangers, supports, clamps, and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to

be supported together on trapeze type hangers where possible. Install supports with spacing's indicated and in compliance with NEC requirements.

END OF SECTION 26 05 29

SECTION 26 05 30 - ELECTRICAL CONNECTIONS FOR 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. This section is a Division-26 Basic Electrical Materials and Methods section, and is part of each Division-23 and 26 section making reference to electrical connections for equipment specified herein.

1.2 DESCRIPTION OF WORK

- A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.
- B. Applications of electrical power connections specified in this section include the following:
 - 1. From electrical source to motor starters.
 - 2. From motor starters to motors.
 - 3. To lighting fixtures.
 - 4. To grounds including earthing connections.
 - 5. To equipment of communication, CCTV and alarm systems.
 - 6. To fuel dispensing equipment.
- C. Electrical connections for equipment, not furnished as integral part of equipment, are specified in Division-23 and other Division-26 sections, and are work of this section.
- D. Motor starters and controllers, not furnished as integral part of equipment, are specified in applicable Division-26 sections, and are work of this section.
- E. Refer to Division-23 specification sections and drawings for motor starters and controllers furnished integrally with equipment; not work of this section. Connections to this equipment is work of this section.
- F. Junction boxes and disconnect switches required for connecting motors and other electrical units of equipment are specified in applicable Division-26 sections, and are work of this section.

- G. Raceways and wires/cables required for connecting motors and other electrical units of equipment are specified in applicable Division-26 sections, and are work of this section.
- H. Refer to other Division-26 and Division-23 sections for low voltage control system wiring; not work of this section.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors and terminals, of types and ratings required, and ancillary connection materials, including electrical insulating tape, soldering fluxes, and cable ties, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 2 years of successful installation experience with projects utilizing electrical connections for equipment similar to that required for this project.
- C. NEC Compliance: Comply with applicable requirements of NEC as to type products used and installation of electrical power connections (terminals and splices), for junction boxes, motor starters, and disconnect switches.
- D. IEEE Compliance: Comply with Std 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to connections and terminations.
- E. ANSI Compliance: Comply with applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.
- F. UL Compliance: Comply with UL Std 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors", including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials which are UL-listed and labeled.
- G. ETL Compliance: Provide electrical connection products and materials which are ETL-listed and labeled.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
 - 1. AMP Incorporated

2. Appleton Electric Co.
3. Arrow-Hart Div., Crouse-Hinds Co.
4. Burndy Corporation
5. General Electric Co.
6. Gould, Inc.
7. Harvey Hubbell Inc.
8. Square D Company
9. Thomas and Betts Corp.

2.2 MATERIALS AND COMPONENTS

- A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wirenuts, and other items and accessories as needed to complete splices and terminations of types indicated.
- B. Metal Conduit, Tubing, and Fittings:
 1. General: Provide metal conduit, tubing, and fittings of types, grades, sizes, and weights (wall thicknesses) indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements and comply with NEC requirements for raceways. Provide products complying with Division-16 basic electrical materials and methods section "Raceways", and in accordance with the following listing of metal conduit, tubing, and fittings:
 - a. Rigid steel conduit.
 - b. Rigid metal conduit fittings.
 - c. Electrical metallic tubing.
 - e. Liquid-tight flexible metal conduit.
 - f. Liquid-tight flexible metal conduit fittings.
 - g. Flexible metal conduit.
 - h. Flexible metal conduit fittings.

- i. Explosion proof fittings and installation methods
- C. Wires, Cables, and Connectors:
 - 1. General: Provide wires, cables, and connectors complying with Division-16 basic electrical materials and methods section "Wires and Cables".
 - 2. Wires/Cables: Unless otherwise indicated, provide wires/cables (conductors) for electrical connections which match, including sizes and ratings, of wires/cables which are supplying electrical power. Provide copper conductors with conductivity of not less than 98% at 20oC (68oF).
 - 3. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals and are recommended by equipment manufacturer for intended applications.
 - 4. Provide explosion proof seals and connections where required in hazardous areas as defined by the National Electrical Code, Article 500 and Article 514.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect area and conditions under which electrical connections for equipment are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF ELECTRICAL CONNECTIONS

- A. Install electrical connections as indicated; in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA's "Standard of Installation", to ensure that products fulfill requirements.
- B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.
- C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
- D. Provide the following electrical work as work of this section, complying with requirements of Division 15 sections:

1. Power supply wiring from power source to power connection on chiller, fans, air handling units, pumps, duct heaters, water heaters, air compressor, air dryer, and unit control panels. Include starters, disconnects, time clocks, receptacles and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer. Make all final electrical connections.
- E. Where applicable, maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect/Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting-over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.
 - F. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced. No new conductors shall be spliced unless specifically noted on the drawings.
 - G. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.
 - H. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing, and maintenance.
 - I. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torquing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL's 486A.
 - J. Provide flexible conduit for motor connections, and other electrical equipment connections, where subject to movement and vibration.
 - K. Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration, and also where connections are subjected to one or more of the following conditions:
 1. Exterior location.
 2. Moist or humid atmosphere where condensate can be expected to accumulate.

3. Corrosive atmosphere.
4. Water spray.
5. Dripping oil, grease, or water, including kitchen areas.

3.3 FIELD QUALITY CONTROL

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

END OF SECTION 26 05 30

SECTION 26 05 33 - RACEWAYS

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. This section is a Division-26 Basic Electrical Materials and Methods section, and is part of each Division-26 section making reference to electrical raceways specified herein.

1.2 DESCRIPTION OF WORK

- A. Extent of raceway work is indicated by drawings and schedules. Types of raceways specified in this section include the following:
 - 1. Electrical metallic tubing (EMT).
 - 2. Liquid tight flexible metal conduit.
 - 3. Rigid metal conduit.
 - 4. Flexible metal conduit.
 - 5. Rigid non-metallic conduit.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with electrical raceway work similar to that required for this project.
- C. Codes and Standards:
 - 1. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publications pertaining to raceways.
 - 2. UL Compliance and Labeling: Comply with applicable requirements of UL safety standards pertaining to electrical raceway systems. Provide raceway products and components which have been UL-listed and labeled.

3. NEC Compliance: Comply with applicable requirements of NEC pertaining to construction and installation of raceway systems.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of raceway system required. Include data substantiating that materials comply with requirements.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. General: Provide metal conduit, tubing, and fittings of types, grades, sizes, and weights (wall thicknesses) for each service indicated. Die-cast fittings are not acceptable.
- B. Rigid Steel Conduit: Provide rigid steel, zinc-coated, threaded type conforming to FS WW-C-581, ANSI C80.1 and UL 6.
- C. Rigid Metal Conduit Fittings: Cast malleable iron, galvanized or cadmium plated, conforming to FS W-F-408, ANSI C80.4.
 1. Use compression type fittings for raintight connections.
 2. Use compression type fittings for other miscellaneous connections.
- D. Electrical Metallic Tubing (EMT): FS WW-C-563, ANSI C80.3 and UL 797.
- E. EMT Fittings: FS W-F-408, ANSI C80.4. Die cast or malleable iron.
 1. Use compression fittings for raintight connections.
 2. Use compression type for concrete type connections.
 3. Use compression type fittings for miscellaneous connections.
 4. Set screw fitting may be used only where conduits and associated fittings are concealed from view.
- F. Liquid-Tight Flexible Metal Conduit: Provide liquid-tight flexible metal conduit; construct of single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coat with liquid-tight jacket of flexible polyvinyl chloride (PVC). Shall be Sealtite or equal.
- G. Liquid-Tight Flexible Metal Conduit Fittings: FS W-F-406, Type 1, Class 3, Style G. Provide cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated, or non-insulated throat.

- H. Flexible Metal Conduit: FS WW-C-566 and UL 1. Formed from continuous length of spiral wound, interlocked zinc-coated strip steel.
- I. Flexible Metal Conduit Fittings: Provide conduit fittings for use with flexible steel conduit of threadless hinged clamp type.
 - 1. Straight Terminal Connectors: One piece body, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.
 - 2. 45o or 90o Terminal Angle Connectors: Two-piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

2.2 NONMETALLIC CONDUIT

- A. General: Provide nonmetallic conduit, ducts, and fittings of types, sizes, and weights for each service indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements which comply with provisions of NEC for raceways.
- B. Electrical Plastic Conduit:
 - 1. Heavy Wall Conduit: Schedule 40, 90 C, UL-rated, construct of polyvinyl chloride and conforming to NEMA TC-2, for direct burial, or normal above ground use, UL-listed and in conformity with NEC Article 352, ANSI C33.91.
- C. PVC Conduit and Tubing Fittings: NEMA TC 3, mate and match to conduit or tubing type and material.

2.3 MANUFACTURERS

- A. Subject to compliance with requirements, provide conduit bodies of one of the following:
 - 1. Appleton Electric; Div of Emerson Electric Co.
 - 2. Arrow-Hart Div; Crouse-Hinds Co.
 - 3. Bell Electric Div; Square D Co.
 - 4. Gould, Inc.
 - 5. Killark Electric Mfg. Co.
 - 6. O-Z/Gedney Div; General Signal Co.

7. Spring City Electrical Mfg. Co., or equivalent.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which raceways are to be installed, and substrate which will support raceways. Notify Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF RACEWAYS

- A. General: Install raceways as indicated; in accordance with manufacturer's written installation instructions, and in compliance with NEC, and NECA's "Standards of Installation". Install units plumb and level, and maintain manufacturer's recommended clearances.
- B. Coordinate with other work including wires/cables, boxes, and panel work, as necessary to interface installation of electrical raceways and components with other work.

3.3 INSTALLATION OF CONDUITS

- A. General: Install concealed conduits in new construction work, either in walls, slabs, or above hung ceilings. Run conduits concealed in existing work where practical or specifically indicated on the drawings.
 1. Mechanically fasten together metal conduits, enclosures, and raceways for conductors to form continuous electrical conductor. Connect to electrical boxes, fittings, and cabinets to provide electrical continuity and firm mechanical assembly.
 2. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.
 3. Install miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs that have been specifically designed and manufactured for their particular application. Install expansion fittings in raceways every 200' of linear run or wherever structural expansion joints are crossed.
- B. Conduit Installation: Follow minimum requirements in all areas as follows:
 1. Use rigid steel galvanized conduit where exposed in the central plant, where exposed to weather or subject to saturation with liquids, and where exposed to potential mechanical damage. Also use rigid steel galvanized

conduit for all risers from underground, except as allowed for conduits used for communications systems. All rigid elbows and rigid risers to cabinets shall be applied with bitumastic paint where below grade.

- a. Raceways above ground and exposed to the exterior for new fiber backbone shall be either galvanized rigid steel or intermediate aluminum. EMT or pvc will not be permitted. All supports, fasteners, connectors, etc., shall be galvanized steel, stainless steel, or a rigid type aluminum.
2. Use steel EMT above hung ceilings in offices, corridors, toilets, and other areas with hung ceilings. EMT may be used in mechanical and electrical rooms, except for the central plant and other areas requiring rigid steel galvanized conduit as in (1.) above.
3. Use PVC heavy wall direct buried rated (Schedule 40) when raceways run below grade, under floors on grade or in concrete. All bends and elbows greater than 45 degrees shall be galvanized rigid steel conduit. All risers from underground to cabinets and boxes when conduit is to be exposed shall be rigid steel conduit.
4. Underground telecommunications conduits for voice/data, fire alarm, intercom, and TV may be all direct buried rated Schedule 40 PVC.
5. Conduit in walls to recessed panels and boxes shall be in accordance with NEC. PVC up to first point of termination with 4'-0" maximum in wall and EMT above 4'-0".
6. Use flexible conduit in movable partitions and from outlet boxes to lighting fixtures, and final 24" of connection to motors, control items or any equipment subject to movement or vibration, and in cells of precast concrete panels. Flexible conduit shall not exceed 6 feet long.
7. Use liquid-tight flexible conduit where subjected to one or more of the following conditions:
 - a. Exterior location.
 - b. Moist or humid atmosphere where condensate can be expected to accumulate. Mechanical rooms.
 - c. Corrosive atmosphere.
 - d. Subjected to water spray or dripping oil, water, or grease, including kitchen equipment connections.
8. Use hot-dipped galvanized conduit where conduit is routed outdoors or in anyway exposed to weather.

9. Surface mounted raceways in finished areas are not permitted.
 10. Electrical contractor will be responsible for the following for all underground conduits:
 - a. Trenching and Excavation
 - b. Backfill
 - c. Compaction
 - d. Entrances into and exits from buildings shall be underground, concealed. See Specification Sections 01731 and 01732.
 11. MC cable or other armored cabling systems shall not be permitted.
 12. Provide explosion proof seals, and associated code compliant raceway system installation, where required in hazardous areas as defined by the National Electrical Code, Article 500 and Article 514.
- C. Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean.
 - D. Field bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.
 - E. Minimum conduit size shall be 1/2" unless noted otherwise. Homeruns shall be a minimum 3/4".
 - F. Fasten conduit terminations in sheet metal enclosures by two (2) locknuts, and terminate with bushings and grounded. Install locknuts inside and out side enclosure.
 - G. Conduits are not to cross pipe shafts, or ventilating duct openings.
 - H. Keep conduits a minimum distance of 6" from parallel runs of flues, hot water pipes or other sources of heat. Wherever possible, install horizontal raceway runs above water and steam piping.
 - I. Use of running threads at conduit joints and terminations is prohibited. Where required, use 3-piece union or split coupling.
 - J. Complete installation of electrical raceways before starting installation of cables/wires within raceways.
 - K. Install conduits so as not to damage or run through structural members. Avoid horizontal or cross runs in building partitions or side walls.
 - L. Exposed Conduits in Unfinished Areas:

1. Install exposed conduits and extensions from concealed conduit systems neatly, parallel with, or at right angles to walls of building.
2. Install exposed conduit work as not to interfere with ceiling inserts, lights or ventilation ducts or outlets.
3. Support all conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed following: up to 1": 6'-0"; 1-1/4" and over: 8'-0". All conduits shall be adequately supported to prevent any noticable deflection, vibration or rattle.
4. Run conduits for outlets on waterproof walls exposed. Set anchors for supporting conduit on waterproof wall in waterproof cement.
5. Exposed conduits on the outside of buildings is not permitted.

M. Conduit Fittings:

1. Construct locknuts for securing conduit to metal enclosure with sharp edge for digging into metal, and ridged outside circumference for proper fastening.
2. Bushings for terminating conduits smaller than 1- 1/4" are to have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable insulation.
3. Install insulated type bushings for terminating conduits 1-1/4" and larger. Bushings are to have flared bottom and ribbed sides. Upper edge to have phenolic insulating ring molded into bushing.
4. All bushings of standard or insulated type to have screw type grounding terminal.
5. Miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs to be specifically designed for their particular application.

N. Concealed Conduits:

1. Metallic raceways installed underground or in floors below grade, or outside are to have conduit threads painted with corrosion inhibiting compound before couplings are assembled. Draw up coupling and conduit sufficiently tight to ensure watertightness.
2. Conduit in concrete slabs: Separate conduits by not less than diameter of largest conduit to ensure proper concrete bond. Conduits must have a minimum of three-quarter inch (3/4") concrete cover.

3. Embedded conduit diameter is not to exceed one-third (1/3) of slab thickness. Conduit shall not be run in slabs less than 3 inches thick.

O. Painting of Conduit & Boxes:

1. Fire Alarm: All new fire alarm conduit, including underground conduit, shall be spot painted red at a minimum of every 4 feet, nominally. Underground conduit shall be spot painted red after it is laid in trench and made up tight. All fire alarm junction boxes shall be painted red.
2. Intercom System: All new junction boxes above ceiling shall be painted blue.
3. Instructional TV System: All new junction boxes above ceiling shall be painted green.
4. Security System: All new junction boxes above ceiling shall be painted yellow.
5. 208Y/120 volt Power: All new junction boxes above ceiling shall be painted brown.
6. 480Y/277 volt Power: All new junction boxes above ceiling shall be painted orange.
7. Emergency Power (if applicable): All new junction boxes above ceiling shall be painted pink.

P. Provide a continuous yellow marker tape with metallic tracer 6 inches above all new underground conduit.

Q. Underground Duct Banks and Underground Conduits: All underground conduits shall be installed per the National Electrical Code, in accordance with standard industry practices and in accordance with other sections of these specifications. Conduits in duct banks shall be neatly and securely installed in straight lines with manufactured elbows used for all turns and bends. Provide all required trenching, excavation, backfill, compaction, supports, manholes, etc. for a complete installation. Trenching, excavation, backfill and compaction shall be performed in accordance with applicable sections of these specifications.

1. Coordinate routing of site raceways with all site piping including new chilled water piping and fire protection piping, plus existing sanitary, storm, and other site utilities. Hand dig in congested areas.

R. Low Voltage Control:

1. Mechanical contractor (Division 23) to provide and install all necessary wire and raceway (EMT conduit) for low voltage control such as

thermostats, timers etc., unless specifically shown otherwise on the drawings. Raceways shall be installed in accordance with Division 26 sections. Final wire connections shall be by mechanical contractor.

3.4 INSTALLATION OF RACEWAYS AND WIREWAYS

- A. General: Mechanically assemble metal enclosures, and raceways for conductors to form continuous electrical conductor, and connect to electrical boxes, fittings and cabinets as to provide effective electrical continuity and rigid mechanical assembly.
1. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembling.
 2. Install expansion fittings in all raceways wherever structural expansion joints are crossed.
 3. Make changes in direction of raceway run with proper fittings, supplied by raceway manufacturer. No field bends of raceway sections will be permitted.
 4. Properly support and anchor raceways for their entire length by structural materials. Raceways are not to span any space unsupported. Supporting conduits from ceiling grid, other conduits, ductwork or other non-structural members will not be permitted.
 5. Use boxes as supplied by raceway manufacturer wherever junction, pull or devices boxes are required. Standard electrical "handy" boxes, etc. shall not be permitted for use with surface raceway installations.
 6. Provide watertight seals in all conduits which cross from one temperature to another temperature extreme, such as coolers and freezers.
 7. All fire wall and smoke wall penetrations shall be sealed using a UL Listed fire stopping method. Method shall be submitted and approved by the Architect/Engineer.
 8. All empty conduits shall have a 1/8" nylon pull rope installed, including all underground conduits.

3.5 COMMUNICATIONS SYSTEMS RACEWAY

- A. Communications systems raceways shall be provided for each voice/data, fire alarm, or other system outlet or device indicated on the drawings, where applicable.

END OF SECTION 26 05 33

SECTION 26 05 35 - ELECTRICAL BOXES AND FITTINGS

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. This section is a Division-26 Basic Electrical Materials and Methods section, and is a part of each Division-26 section making reference to electrical wiring boxes and fittings specified herein.

1.2 DESCRIPTION OF WORK

- A. Extent of electrical box and associated fitting work is indicated by drawings and schedules.
- B. Types of electrical boxes and fittings specified in this section include the following:
 - 1. Outlet boxes
 - 2. Junction boxes
 - 3. Pull boxes
 - 4. Floor boxes
 - 5. Bushings
 - 6. Locknuts
 - 7. Knockout closures
 - 8. Manholes and handholes

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical boxes and fittings, of types, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects utilizing electrical boxes and fittings similar to those required for this project.

- C. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.
- D. UL Compliance: Comply with applicable requirements UL 50, UL 514-Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings which are UL-listed and labeled.
- E. NEMA Compliance: Comply with applicable requirements of NEMA Stds/Pub No.'s OS1, OS2, and Pub 250 pertaining to outlet and device boxes, covers, and box supports.

PART 2 - PRODUCTS

2.1 FABRICATED MATERIALS

- A. Outlet Boxes: Provide galvanized coated flat rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.
 - 1. Recessed outlet boxes shall be a minimum 4" square by 2-1/2" deep with reducer ring for a standard outlet coverplate. Where surface mounted devices are necessary provide 2-1/2" x 4" x 2-1/2" deep box to fit a standard coverplate. Shallow boxes shall not be permitted for communications outlet boxes.
 - 2. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.
- B. Device Boxes: Provide galvanized coated flat rolled sheet-steel non-gangable device boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, and with cable-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices. Provide cable clamps and corrosion-resistant screws for fastening cable clamps, and for equipment type grounding.
 - 1. Recessed outlet boxes shall be a minimum 4" square by 2-1/2" deep with reducer ring for a standard outlet coverplate. Where surface mounted devices are necessary provide 2-1/2" x 4" x 2-1/2" deep box to fit a

standard coverplate. Shallow boxes shall not be permitted for communications outlet boxes.

2. Device Box Accessories: Provide device box accessories as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster board expandable grip fasteners, which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.
- C. Available Manufacturers: Subject to compliance with requirements, manufacturers offering outlet boxes which may be incorporated in the work include, but are not limited to, the following:
1. Appleton Electric;
 2. Bell Electric;
 3. Eagle Electric Mfg. Co.; Inc.
 4. Midland-Ross Corp.
 5. OZ/Gedney; General Signal Co.
 6. Pass and Seymour, Inc.
 7. RACO Div.; Harvey Hubbell Inc.
 8. Thomas & Betts Co.
- D. Raintight Outlet Boxes: Provide corrosion-resistant cast-metal raintight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, cast-metal face plates with spring hinged watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners.
- E. Available Manufacturers: Subject to compliance with requirements, manufacturers offering raintight outlet boxes which may be incorporated in the work include, but are not limited to, the following:
1. Appleton Electric;
 2. Crouse-Hinds Co.
 3. Bell Electric;
 4. Harvey Hubbell, Inc.
 5. OZ/Gedney; General Signal Co.

6. RACO Div.

- F. Junction and Pull Boxes: Provide galvanized code-gage sheet steel junction and pull boxes; with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws, and washers.
- G. Available Manufacturers: Subject to compliance with requirements, manufacturers offering junction and pull boxes which may be incorporated in the work include, but are not limited to, the following:
1. Appleton Electric; Emerson Electric Co.
 2. Arrow-Hart Div.; Crouse-Hinds Co.
 3. Electric; Square D Company
 4. OZ/Gedney; General Signal Co.
 5. Spring City Electrical Mfg. Co.
- H. Available Manufacturers: Subject to compliance with requirements, manufacturers offering floor boxes which may be incorporated in the work include, but are not limited to, the following:
1. Arrow-Hart Div.; Crouse-Hinds Co.
 2. Harvey Hubbell, Inc.
 3. Midland-Ross Corp.
 4. Spring City Electrical Mfg. Co.
- I. Bushings, Knockout Closures, and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connections, of types and sizes, to suit respective installation requirements and applications.
- J. Available Manufacturers: Subject to compliance with requirements, manufacturers offering bushings, knockout closures, locknuts, and connectors which may be incorporated in the work include, but are not limited to, the following:
1. Arrow-Hart Div.; Crouse-Hinds Co.
 2. Appleton Electric Co.; Emerson Electric Co.
 3. Bell Electric; Square D Co.

4. Midland-Ross Corp.
 5. OZ/Gedney Co.; General Signal Co.
- K. Manholes and Handholes: Manholes and handholes for exterior use shall be pre-cast concrete with steel traffic rated covers, as manufactured by Brooks or equal. Pre-manufactured composite type boxes (Quazite or approved equal) are permitted where suitable and rated for the use indicated. Manholes and handholes shall be the size necessary for the number of conduits and conductors indicated on the drawings which will enter the enclosure, plus the necessary capacity for the spare conduits and the associated estimated conductor fill. Provide manholes with the appropriate drainage and knockouts for conduits and other necessary access. Traffic covers shall be engraved with the appropriate identification, such as "ELECTRIC" or "COMMUNICATIONS". Provide plastic protective grommet on all conduit ends for all communications systems conduit inside manholes. Fire alarm conduits shall be marked.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

- A. General: Install electrical boxes and fittings as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
- C. Provide weathertight boxes and fittings for interior and exterior locations exposed to weather or moisture. Provide weatherproof boxes for all exterior outlet boxes for power and systems, including fire alarm and intercom system boxes.
- D. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- E. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.
- F. Avoid installing boxes back-to-back in walls. Provide not less than 24" (600 mm) separation.
- G. Position recessed outlet boxes accurately to allow for surface finish thickness. All outlet boxes shall be provided with bracket support behind the box for additional structural support. Mounting boxes directly to the metal framing on one side only is not acceptable. Boxes shall be additionally supported on the back side.

- H. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry.
- I. Outlet boxes shall be structurally supported to the metal studs using a back bracket or other additional means of support. Side mounted attachment only to the metal studs is not acceptable.
- J. Each circuit in pull box shall be marked with a tag guide denoting panels which they connect to.
- K. Manholes and handholes shall be installed for all underground conduit installations. The minimum number of manholes and handholes shall be as indicated on the drawings. The contractor shall provide any additional handholes or manholes necessary for ease of installation, code compliance or due to voluntary or required re-routing of the underground conduits at no additional cost to the Owner.

END OF SECTION 26 05 35

SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

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. Division-26 Basic Electrical Materials and Methods section apply to work specified in this section.

1.2 DESCRIPTION OF WORK

- A. Extent of electrical identification work is indicated by drawings and schedules.
- B. Types of electrical identification work specified in this section include the following:
 - 1. Electrical power, control, and communication conductors.
 - 2. Operational instructions and warnings.
 - 3. Equipment/system identification signs.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical identification products of types required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.
- C. UL Compliance: Comply with applicable requirements of UL Std 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering electrical identification products which may be incorporated in the work include, but are not limited to, the following:
 - 1. Brady, W.H. Co.

2.2 ELECTRICAL IDENTIFICATION MATERIALS

- A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

2.3 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, white face and black core plies (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 - 1. Thickness: 1/8", except as otherwise indicated.
 - 2. Fasteners: Self-tapping stainless steel screws or permanent rivets. Contact-type permanent adhesive will not be acceptable.

2.4 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering, and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. General Installation Requirements:
 - 1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions and requirements of NEC.
 - 2. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.
 - 3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

3.2 OPERATIONAL IDENTIFICATION AND WARNINGS

- A. General: Wherever reasonably required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical

facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and doors of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

3.3 EQUIPMENT/SYSTEM IDENTIFICATION

- A. General: Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication/ control/signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2" high lettering, on 1-1/2" high sign (2" high where 2 lines are required), black lettering in white field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:
1. Switchboard (including all individual circuit breakers and main breaker). Existing labeling shall be removed and updated where changed or added.
 2. Panelboards (including all individual circuit breakers and main breaker on distribution panels).
 3. All electrical cabinets, disconnect switches and enclosures.
 2. Access panel/doors to electrical facilities. Provide building disconnect signage as indicated on the drawings.
 3. Transformers
 4. Equipment disconnects and starters.
 5. Timeclocks, contactors and lighting controls.
 6. Other control stations, such as purge fans, etc.
- B. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate.

END OF SECTION 26 05 53

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes (where applicable):

1. Time switches.
2. Photoelectric switches.
3. Indoor occupancy and vacancy sensors.
4. Digital timer light switches.
5. Low voltage on/off lighting control
6. Low voltage on/off with dimming control
7. Lighting contactors.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:
 - a. Occupancy sensors (if applicable).
 - b. Vacancy sensors (manual on/auto off controls).
 - c. Low voltage dimmers and controls, including emergency shunt and relays
2. Interconnection diagrams showing field-installed wiring method and connections for each individual control scheme, including emergency power bypass controls.
3. Include diagrams for power, signal, and control wiring.
4. Submit layout drawings for all occupancy sensors with manufacturers recommended coverage and device.

1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: For manufacturer's warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control software.
 - b. Faulty operation of lighting control devices, including but not limited to delayed on/off, delayed dimming, flickering of lights, flickering of dimming above 10% dim.
 - 2. Warranty Period: Two year(s) from date of Substantial Completion.

1.6 MANUFACTURERS

Basis of design is Sensorswitch by Acuity. Equal products by Hubbell and Leviton that meet the requirements of the specifications and project requirements are acceptable.

PART 2 - PRODUCTS

2.1 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. General Requirements for Sensors:
 - 1. Wall or Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
 - 2. Dual technology.
 - 3. Separate power pack.
 - 4. Hardwired connection to compatible switch and BAS. On/off switches and on/off dimmer switches shall be 100% compatible with the sensors.
 - 5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

6. Operation:
 - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes. NOTE: PROVIDE VACANCY SENSORS IN ALL LOCATIONS REQUIRED BY THE FLORIDA ENERGY CODE.
7. Sensor Output: Sensor is powered from the power pack.
8. Power: Line voltage.
9. Power Pack: Dry contacts rated for 20-A ballast or LED. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
10. 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.
11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
12. Bypass Switch: Override the "on" function in case of sensor failure.
- B. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
 1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch-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: Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 10 foot high ceiling. Provide for detection coverage for higher ceilings and larger areas as required by the areas indicated on the drawings.

2.2 DIGITAL TIMER LIGHT SWITCH

- A. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval in 10 minute increments.
 1. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 amps at 277-V ac for LED, and 1/4 horsepower at 120-V ac.
 2. Integral relay for connection to BAS.
 3. Voltage: Dual voltage - 120 and 277 V.
 4. Color: White
 5. Faceplate: Nylon plastic, white.

2.3 LOW VOLTAGE DIMMING CONTROLS

- A. Provide low voltage wall mounted lighting control stations with integral manual on/ auto off and 0-10 volt dimming control. Stations shall be compatible with the power packs, vacancy sensors, LED drivers and LED lamps. Dimmers for LED lighting shall be matched with the LED driver and LED types. Submit all dimmers for LED for approval. Submittal shall have written documentation that the dimmer is suitable for use with the specific LED driver and LED's being used in the dimmed fixture. Station shall be white, and provided with a Decora style coverplate, white.

2.4 LOW VOLTAGE LIGHTING CONTROLS

- A. Provide low voltage wall mounted lighting control stations with integral manual on/ auto off. Stations shall be compatible with the power packs, vacancy sensors, LED drivers and LED lamps. Submittal shall have written documentation that the dimmer is suitable for use with the specific LED driver and LED's being used in the dimmed fixture. Station shall be white, and provided with a Decora style coverplate, plastic nylon. Provide for 3-way control where required.

2.5 LOW VOLTAGE LIGHTING CONTROL POWER PACKS

- A. Provide low voltage power packs for the control of the occupancy sensors, daylight harvesting (where indicated), on/off wall stations, and on/off dimming

control stations. Power packs shall be Class 1 high voltage (120/277 volt) to Class 2 low voltage (15 Vdc), plenum rated. Power packs shall meet all codes and all National Electrical Code requirements. Provide single or dual circuit as required. Provide for emergency power circuits and bypass relay controls for automatic illumination of all emergency egress lighting in the event of utility power failure.

2.6 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 WIRING INSTALLATION

- A. Comply with NECA 1.

- B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires 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. Testing Agency: Commissioning agent will evaluate lighting control devices and witness tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Tests shall be performed (or performed again) in the presence of the commissioning agent.

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

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 3 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3.7 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Division 26 Basic Electrical Materials and Methods section apply to work specified in this section.

1.2 DESCRIPTION OF WORK

- A. Extent of panelboard, load-center and enclosure work, including cabinets and cutout boxes is indicated by drawings and schedules.
- B. Types of panelboards and enclosures in this section include the following:
 - 1. Service-entrance panelboards
 - 2. Power-distribution panelboards
 - 3. Lighting and appliance panelboards
- C. Refer to other Division 26 sections for circuit breakers, cable/wire, connectors, and electrical raceway work required in conjunction with panelboards and enclosures; not work of this section.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of panelboards and enclosures, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects utilizing panelboards similar to that required for this project.
- C. NEC Compliance: Comply with NEC as applicable to installation of panelboards, cabinets, and cutout boxes. Comply with NEC requirements pertaining to installation of wiring and equipment in hazardous locations.
- D. UL Compliance: Comply with applicable requirements of Std No. 67 "Electric Panelboards", and Stds No.'s 50, 869, 486A, 486B, and 1053 pertaining to panelboards, accessories and enclosures. Provide units which are UL-listed and labeled.
- E. NEMA Compliance: Comply with NEMA Stds Pub/No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum), Pub/ No. PB 1, "Panelboards", and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less".

- F. Federal Specification Compliance: Comply with FS W-P-115, "Power Distribution Panel", pertaining to panelboards and accessories.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on panelboards. Data must include a complete panel layout indicating the circuit breakers and corresponding circuit numbers. Include ratings of each circuit breaker including short circuit capability. Indicate all options to be supplied with the panelboard. Indicate overall panelboard bus rating and main type and rating. Show complete dimensional information. Any deviation from dimensions shown on the drawings shall be specifically pointed out in the submittal. Indicate the panelboard short circuit capacity rating. Series ratings are acceptable. UL Listed series rating data shall be submitted with the shop drawings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with all of the contract documents, manufacturers offering products that meet the requirements of these specifications may be considered. The following are considered acceptable, subject to compliance with these specifications:
 - 1. Square D
 - 2. General Electric
 - 3. Siemens
 - 4. Eaton/Cutler Hammer.
- B. All circuit breakers shall be the bolt-on type.

2.2 PANELBOARDS

- A. General: Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; design and construction in accordance with published product information; equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.
- B. Power Distribution Panelboards: Provide dead-front safety type power distribution panelboards as indicated, with panelboard switching and protective devices in quantities, ratings, types, and with arrangement shown; with anti-turn solderless pressure type main lug connectors approved for copper conductors. Select unit with feeder connecting at top of panel. Equip with copper bus bars with not less than 98% conductivity, and with full-sized neutral bus; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections.

Provide bolt-on type molded-case main and branch circuit-breaker types for each circuit, with toggle handles that indicate when tripped. Where multiple-pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Provide panelboards with bare uninsulated copper grounding bars suitable for bolting to enclosures. Select flush or surface mounted type enclosures, required on the drawings, fabricated by same manufacturer as panelboards, which mate properly with panelboards.

- C. **Lighting and Appliance Panelboards:** Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types, and arrangements shown; with anti-burn solderless pressure type lug connectors approved for copper conductors; construct unit for connecting feeders at top of panel; equip with copper bus bars, full-sized neutral bar, with bolt-in type heavy-duty, quick-make, quick-break, single-pole or multi-pole circuit-breakers, with toggle handles that indicate when tripped. Provide suitable lugs on neutral bus for each outgoing feeder required; provide bare copper uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate properly with panelboards. Loadcenters are not acceptable.
- D. **Panelboard Enclosures:** Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage, minimum 16-gage thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with wire gutters and without multiple knockouts. Provide fronts with adjustable trim clamps, doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed piano door hinges. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor coating. Design enclosures for flush recessed or surface mounting, as indicated on the drawings. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate properly with panelboards to be enclosed.
- E. **Panelboard Accessories:** Provide panelboard accessories and devices including, but not necessarily limited to, cartridge and plug time-delay type fuses, circuit-breakers, ground-fault protection units, etc., as recommended by panelboard manufacturer for ratings and applications indicated. All panelboards shall be provided with a separate copper ground bus bar.
- F. **Panelboard Ratings:** All panelboards shall be fully or series rated for the short circuit current indicated or the specific rating specified on the panel schedule, whichever is greater.
- G. **Surge Suppression:** Provide externally mounted surge suppressor.
 - 1. In all cases, the panelboards and the surge suppression devices shall be submitted for approval as a package at the same time. One will not be approved without the other.

2. Coordinate requirements for connection with the surge suppression specification section. Provide a three pole, 30 amp (or 30 amp if TVSS call for 30 amp) circuit breaker to serve the surge suppressor.
3. Internally mounted or integrally mounted surge suppression devices are not acceptable and will not be accepted.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Installer must examine areas and conditions under which panelboards and enclosures are to be installed, and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF PANELBOARDS

- A. General: Install panelboards and enclosures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standard of Installation", and in compliance with recognized industry practices, to ensure that products comply with requirements.
- B. Coordinate installation of panelboards and enclosures with cable and raceway installation work.
- C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B.
- D. Anchor enclosures firmly and securely to walls and structural surfaces, ensuring that they are permanently and mechanically secure and plumb.
- E. Provide properly wired electrical connections within enclosures.
- F. Provide typewritten circuit directory card in panel door upon completion of installation work.
- G. Where panels are mounted flush in the wall, a minimum of three (3) spare 3/4" conduit shall be installed stubbed out a minimum of eight (8) inches above ceiling.

3.3 GROUNDING

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

3.4 FIELD QUALITY CONTROL

- A. Prior to energization of circuitry, check all accessible connections to manufacturer's tightening torque specifications.
- B. Prior to energization of panelboards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
- C. Prior to energization, check panelboards for electrical continuity of circuits for short-circuits.
- D. Subsequent to wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.
- E. Prior to final acceptance completely fill out the circuit directories accurately depicting the equipment connected to each circuit. Circuit directories shall be typewritten. Handwritten is not acceptable.

3.5 WARRANTY

- A. All panelboards shall be guaranteed against defective material and workmanship in accordance with the manufacturers published warranty for a minimum of one year from the date of the substantial completion. Warranty shall be published in the name of the Owner, not the contractor.

END OF SECTION 26 24 16

SECTION 26 26 16 - CIRCUIT AND MOTOR DISCONNECTS

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. Division-26 Basic Electrical Materials and Methods section, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of circuit and motor disconnect switch work is indicated by drawings and schedules.
- B. Types of circuit and motor disconnect switches in this section include the following:
 - 1. Equipment disconnects.
 - 2. Appliance disconnects.
 - 3. Motor-circuit disconnects.
- C. Wires/cables, raceways, and electrical boxes and fittings required in connection with circuit and motor disconnect work are specified in other Division-26 Basic Electrical Materials and Methods sections.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of circuit and motor disconnect switches of types and capacities required whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing circuit and motor disconnect work similar to that required for this project.
- C. NEC Compliance: Comply with NEC requirements pertaining to construction and installation of electrical circuit and motor disconnect devices.
- D. UL Compliance: Comply with requirements of UL 98, "Enclosed and Dead-Front Switches". Provide circuit and motor disconnect switches which have been UL-listed and labeled.

- E. NEMA Compliance: Comply with applicable requirements of NEMA Stds Pub No. KS 1, "Enclosed Switches" and 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)".

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on circuit and motor disconnect switches.
- B. Wiring Diagrams: Submit power and control wiring diagrams for circuit and motor disconnects including connections to power and control panels, and feeders.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering circuit and motor disconnects which may be incorporated in the work include the following:
 - 1. General Electric Co.
 - 2. Square D Company
 - 3. ITE/Seimens

2.2 FABRICATED SWITCHES

- A. Heavy-Duty Safety Switches: Provide surface-mounted, heavy-duty type, sheet-steel enclosed safety switches, of types, sizes and electrical characteristics indicated; fusible or non-fusible type as indicated, amperes as indicated, 60 Hz, 3-blades, 4-poles, solid neutral; and incorporating quick-make, quick-break type switches; construct so that switch blades are visible in OFF position with door open. Equip with operating handle which is integral part of enclosure base and whose operating position is easily recognizable, and is padlockable in OFF position; construct current carrying parts of high-conductivity copper, with silver-tungsten type switch contacts, and positive pressure type reinforced fuse clips. Provide NEMA Type 3R enclosures, where applicable. Provide grounding kit. Provide 240 volt rated switches for 208Y/120 volt systems and 600 volt rated switches for 277Y/480 volt systems.
 - 1. Fuses: Provide fuses for safety switches, sized as recommended by the manufacturer of the equipment to be protected, of classes, types, and ratings needed to fulfill electrical requirements for service indicated. Provide R-clips for all fuse holders.

PART 3 - EXECUTION

3.1 INSTALLATION OF CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Install circuit and motor disconnect switches as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation", and in accordance with recognized industry practices.
- B. Coordinate circuit and motor disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.
- C. Install disconnect switches for use with motor-driven appliances, and motors and controllers within sight of controller position unless otherwise indicated.
- D. Provide a nameplate indicating the equipment served and protected.

3.2 GROUNDING

- A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground, for electrical disconnect switches where indicated.

3.3 FIELD QUALITY CONTROL

- A. Subsequent to completion of installation of electrical disconnect switches, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance; otherwise remove and replace with new units and retest.
- B. Painting: repair all scratches to factory painted and primed finish with factory supplied touch-up paint.

END OF SECTION 26 26 16

SECTION 26 07 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. This section is a Division-26 Basic Electrical Materials and Methods section, and is part of each Division-26 section making reference to wiring devices specified herein.
- C. Refer to section 26 09 23 Lighting Control Devices for coordination of low voltage lighting controls.

1.2 DESCRIPTION OF WORK

- A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems which are intended to carry but not utilize electric energy.
- B. Types of electrical wiring devices in this section include the following:
 - 1. Receptacles
 - 2. Ground-fault circuit interrupters
 - 3. Line voltage switches
 - 4. Wallplates
 - 5. Plugs and connectors

1.3 QUALITY ASSURANCE

- A. Installer's Qualifications: Firm with at least 2 years of successful installation experience on projects utilizing wiring devices similar to those required for this project.
- B. NEC Compliance: Comply with NEC as applicable to installation and wiring of electrical wiring devices.
- C. UL Compliance: Comply with applicable requirements of UL 20, 486A, 498, and 943 pertaining to installation of wiring devices. Provide wiring devices which are UL-listed and labeled.
- D. IEEE Compliance: Comply with applicable requirements of IEEE Std 241, "Recommended Practice for Electric Power Systems in Commercial Buildings", pertaining to electrical wiring systems.

- E. NEMA Compliance: Comply with applicable portions of NEMA Std's Pub/No. WD 1, "General-Purpose Wiring Devices", WD 2, "Semiconductor Dimmers for Incandescent Lamps", and WD 5, "Specific-Purpose Wiring Devices".
- F. FS Compliance: Comply FS W-C-596 (Series) and FS W-S-896 (Series) pertaining to electrical power connectors and toggle switches.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on all electrical wiring devices.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with all of the contract documents, manufacturers offering products that meet the requirements of these specifications may be considered.

2.2 FABRICATED WIRING DEVICES

- A. General: Provide factory-fabricated wiring devices, in types, colors, and electrical ratings for applications indicated and which comply with NEMA Std's Pub/No. WD 1. Provide colors indicated below and nylon plastic type coverplates, except as otherwise indicated. All color selections to be verified by Contractor with Architect-Engineer.

- 1. Important Note: Some areas will require specific wiring device types. See below and drawings for specific requirements in these areas.

- B. Receptacles:

- 1. Heavy-Duty Duplex: Provide specification grade duplex receptacles, 2-pole, 3-wire, grounding, 20-amperes, 125-volts, with metal plaster ears, design for side and back wiring with spring loaded, screw activated pressure plate, with NEMA configuration 5-20R unless otherwise indicated.
- 2. Ground-Fault Interrupters: Provide "feed-thru" type ground-fault circuit interrupters, with heavy-duty duplex receptacles, capable of protecting connecting downstream receptacles on single circuit, and of being installed in a 2-3/4" deep outlet box without adapter, grounding type UL-rated Class A, Group 1, rated 20 amperes, 120-volts, 60 Hz; with solid-state ground-fault sensing and indication; with 5 milliamperes ground-fault trip level; equip with NEMA configuration 5-20R. Device must have a positive trip identification and reset.
- 3. Special Receptacles: Special configuration receptacles shall be standard NEMA plug configuration as specified on the drawings or as required.

Provide heavy duty, specification grade receptacles, with black nylon face and brushed satin stainless steel cover plate.

4. Receptacle Colors (confirm all color with architect prior to ordering):

- a. General use receptacles: White.

C. Switches:

1. Snap: Provide general-duty flush single-pole, quiet type toggle switches, 20-amperes, 120-277 volts AC, with mounting yoke insulated from mechanism, equip with plaster ears, switch handle, and side-wired screw terminals.
2. 2-way: Provide general-duty flush double-pole AC quiet switches, 20-amperes, 120-277 volts AC, with mounting yoke insulated from mechanism, equip with plaster ears, switch handles, side-wired screw terminals, with break-off tab features, which allows wiring with separate or common feed.
3. Three-way: Provide general-duty flush 3-way AC quiet type switches, 20-amperes, 120-277 volts AC, with mounting yoke insulated from mechanism, equip with plaster ears, lock type switch handles, sidewired screw terminals, with break-off tab features, which allows wiring with separate or common feed.
4. Four-way: Provide general-duty flush 4-way AC quiet switches, 20-amperes, 120-277 volts AC, with mounting yoke insulated from mechanism, equip with plaster ears, switch handles, side-wired screw terminals, with break-off tab features, which allows wiring with separate or common feed.
5. Touch Snap: Provide soft-touch snap switches, cap able of effortless-fingertip operation; single-pole AC quiet, with lighted rocker switch handles; sidewired screw terminals for connecting copper-clad aluminum wire, 20-amperes, 120-277 volts rating. Equip with plaster ears.
6. Switches to be white color with nylon plastic coverplate.
7. Note: Most of the lighting controls shgall be low voltage. Use these specification for line voltage switches only. See specification section 26 0923 for low voltage lighting controls.

2.3 WIRING DEVICE ACCESSORIES

- A. Wallplates: Provide wallplates for single and combination wiring devices, of types, sizes, and with ganging and cutouts as required. Select plates which mate and match wiring devices to which attached. Construct with metal screws for

securing plates to devices; screw heads colored to match finish of plates. Provide plates possessing the following additional construction features:

1. Material and Finish: Nylon plastic, white.
- B. Floor Service Outlets: Provide flush type floor service receptacle outlets and fittings of types and ratings indicated. Refer to the AT (Technology) drawings and associated specifications for box requirements and selections. Provide boxes, as indicated on the drawings, with 20-ampere, 125-volt, duplex (or quad) receptacle, NEMA configuration 5-20R for power, unless indicated otherwise.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES

- A. Install wiring devices as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other work, including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices with other work.
- C. Install wiring devices only in electrical boxes which are clean; free from excess building materials, dirt, and debris.
- D. Install galvanized steel wallplates on any exposed surface mounted devices. Install weatherproof type covers for all devices that are exposed to the weather.
- E. Install wallplates after painting work is completed.
- F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B. Use properly scaled torque indicating hand tool.
- G. Contractor to provide ground fault protective type receptacles for any location within 6'-0" of sinks or other source of water. Feed through protection from one ground fault protected receptacle on a circuit is not acceptable.
- H. Mounting height of boxes for devices as shown on legend, unless otherwise noted on the plan. Refer to architectural drawings to avoid interferences with millwork. Where two or more devices are shown at the same location, use gang box and one face plate. Verify all device locations with Owner prior to rough-in. Exact device locations may be adjusted by the Owner to avoid interferences or for general convenience at no additional cost to the Owner.

- I. Floor boxes shall be installed flush with the slab and shall strictly follow manufacturer's installation instructions. Boxes shall be installed at right angles to the building lines and multiple boxes shall be in-line straight and even. Boxes observed to be installed crooked shall be removed and reinstalled.
- J. Set up, adjust, program and test all occupancy sensors and daylighting sensors prior to substantial completion. Make all required adjustments to location, settings, and device type if the sensors are not operating properly in the installed condition.

3.2 PROTECTION OF WALLPLATES AND RECEPTACLES

- A. Upon installation of wallplates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

3.3 GROUNDING

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

3.4 TESTING

- A. Prior to circuitry, test wiring for electrical continuity, for short-circuits and for grounding. Ensure proper polarity of connections is maintained. Subsequent to energization, test wiring devices to demonstrate compliance with requirements.

3.5 WARRANTY

- A. All wiring devices shall have a minimum one year parts and labor warranty.

END OF SECTION 26 27 26

SECTION 26 28 13 - OVERCURRENT PROTECTIVE 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.
- B. This section is a Division-26 Basic Electrical Materials and Methods section, and is part of each Division-26 section making reference to overcurrent protective devices specified herein.

1.2 DESCRIPTION OF WORK

- A. Extent of overcurrent protective device work is indicated by drawings and schedules.
- B. Types of overcurrent protective devices in this section include the following:
 - 1. Circuit Breakers:
 - a. Air, molded-case, for installation in panels.
 - b. Air, molded-case, for individual, separately enclosed mounting.
 - c. For installation in existing panels.
 - 2. Fuses:
 - a. Class RK1 and RK5, dual-element time-delay.
- C. Refer to other Division-26 sections for cable/wire and connector work required in conjunction with overcurrent protective devices; not work of this section.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of overcurrent protective devices, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: Qualified with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for project.
- C. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of overcurrent protective devices.

- D. UL Compliance: Comply with applicable requirements of UL 489, "Molded-Case Circuit Breakers and Circuit-Breaker Enclosures", and UL 198D, "High-Interrupting-Capacity Class K Fuses". Provide overcurrent protective devices which have been UL-listed and labeled.
- E. NEMA Compliance: Comply with applicable requirements of NEMA Std Pub Nos. AB 1, AB 2, and SG 3 pertaining to molded-case and low-voltage power type circuit breakers.
- F. FS Compliance: Comply with Federal Specification W-C-375B/GEN pertaining to molded-case circuit breakers.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on overcurrent protective devices, including: amperes, voltages and current ratings, interrupting ratings, current limitations, internal inductive and non-inductive loads, time-current trip characteristics curves, and mounting requirements.
- B. Maintenance Stock, Fuses: For types and ratings required, furnish additional fuses, amounting to one unit for every 5 installed units, but not less than one unit of each.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include the following:
 - 1. Circuit Breakers:
 - a. General Electric Co.
 - b. Square D Co.
 - c. ITE/Seimens
 - 2. Fuses:
 - a. Bussmann Div.; McGraw-Edison Co.
 - b. Gould, Inc.
 - c. Cefco

2.2 CIRCUIT BREAKERS

- A. General: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings, and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.
- B. Molded-Case Circuit Breakers: Provide factory assembled, molded-case circuit breakers of frame size indicated; rated 600 volts or 240 volts as required, 60 Hz, 3-poles with interrupting ratings as shown on drawings. Provide breakers with permanent thermal and instantaneous magnetic trips in each pole, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle trip indication. Handle ties are not permitted. Provide push-to-trip button on cover for mechanical tripping circuit breakers. Construct breakers for mounting and operating in any physical position and operating in an ambient temperature of 40oC. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated. Circuit breakers shall have the short circuit interrupting rated indicated on the drawings or as required for the short circuit current available.
- C. Molded-Case Circuit Breakers for Installation in Existing Panelboards or Switchboards: Shall meet the same specifications as in Part B above. Shall be manufactured by the same manufacturer as the panelboard or switchboard. When the existing panel or switchboard style is obsolete and the existing circuit breaker type is not available the contractor shall provide a circuit breaker of similar type as existing. The breaker shall be provided with all the required mounting hardware to mount the breaker in the existing space. The breaker shall meet or exceed the ratings of the existing breakers.
- D. Provide all accesories indicated on the drawings, including accesories indicated on the panel schedules, such as shunt trips, ground fault protection, undervoltage trips, etc. Accessories shall be manufactured by the same manufacturer as the circuit breaker.

2.3 FUSES

- A. General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time/current and peak let-through current characteristics indicated, which comply with manufacturer's standard design, materials, and construction in accordance with published product information, and with industry standards and configurations.
- B. Class RK5 Dual-Element Time-Delay Fuses: Provide UL Class RK-5 dual element time-delay fuses rated 600 V, 60 Hz, amperes as required by the

manufacturer of the equipment being protected, with 200,000 RMS symmetrical interrupting current rating for protecting motors.

- C. Class RK1 Dual-Element Time-Delay Fuses: Provide UL Class RK-1 dual element time-delay fuses rated 600 V, 60 Hz, amperes as required by the manufacturer of the equipment being protected, with 200,000 RMS symmetrical interrupting current rating for protecting service entrance or as otherwise noted.

2.4 EXISTING EQUIPMENT

- A. Circuit breakers to be installed in existing equipment shall be manufactured by the existing equipment manufacturer and shall have short circuit interrupting ratings equal to or greater than the existing breakers. Provide all required factory supplied bus connection straps and bus connectors, plus factory supplied filler plates.

PART 3 - EXECUTION

3.1 INSTALLATION OF OVERCURRENT PROTECTIVE DEVICES

- A. Install overcurrent protective devices as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation of overcurrent protective devices.
- B. Coordinate with other work, including electrical wiring work, as necessary to interface installation of overcurrent protective devices with other work.
- C. Fasten circuit breakers without causing mechanical stresses, twisting or misalignment being exerted by clamps, supports, or cabling.
- D. Set field-adjustable circuit breakers for trip settings as indicated, subsequent to installation of units.
- E. Install fuses, if any, in fused circuit breakers.

3.2 ADJUST AND CLEAN

- A. Inspect circuit-breaker operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

3.3 FIELD QUALITY CONTROL

- A. Prior to energization of overcurrent protective devices, test devices for continuity of circuitry and for short-circuits. Correct malfunctioning units, and then demonstrate compliance with requirements.

END OF SECTION 26 28 13

SECTION 26 29 13 - MOTOR CONTROLLERS AND CONTACTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE

- A. The work, apparatus and materials which shall be furnished under these specifications and accompanying drawings shall include all items specified hereinafter and shown on the drawings. All other materials necessary for the complete installation shall be furnished and installed by the Contractor to provide complete electrical systems as indicated on the drawings and as specified herein.
- B. Coordinate all required interlocks with Division 23. Motor starters shall contain the necessary auxiliary contacts and control coil voltage to interface with the HVAC temperature control system and fire alarm control system (if applicable).

1.3 DESCRIPTION OF WORK

- A. Extent of motor controller work is indicated by drawings and schedules. Types of motor controllers specified in this section include the following:
 - 1. Manual motor starters.
 - 2. Combination disconnect/FVNR motor starters.

1.4 QUALITY ASSURANCE

- A. Manufacturers: General Electric, Square D, Allen Bradley.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with electrical motor controller work similar to that required for this project.
- C. Codes and Standards:
 - 1. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publications pertaining to motor controllers.
 - 2. UL Compliance and Labeling: Comply with applicable requirements of UL safety standards pertaining to motor controllers. Provide motor controllers and components which have been UL-listed and labeled.
 - 3. NEC Compliance: Comply with applicable requirements of NEC pertaining to construction and installation of motor controllers.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of motor controller required. Include data substantiating that materials comply with requirements.

PART 2 - PRODUCTS

2.1 INDIVIDUAL MOTOR CONTROLLERS

- A. Manual motor starters for 115 volts, single phase motors one horsepower and smaller, shall be single pole, horsepower rated switches with thermal overload units and heaters. Starters shall be Allen-Bradley Bulletin 609, General Electric CR-101 or Square D Class 2510 with stainless steel cover plates.
- B. Magnetic full voltage starters for three phase motors shall be three pole, horsepower rated, magnetically operated with three electronic overloads sized for the specific motors supplied. Overload "heaters" are not permitted. Starters shall be Allen-Bradley Bulletin 509, General Electric CR-306 or Square D Class 8536. Provide Hand-Off-Auto selector switch, pilot lights to indicate starter's position (Amber - Red - Green), a minimum of two normally open and two normally closed auxiliary contacts, control power transformer fused on primary and secondary, control coil, and three electronic overload relays with automatic reset. Select and provide overload relays that match the supplied motor requirements. Provide control power and coil voltage as required for interlock with the HVAC temperature control system and fire alarm system. Starters shall be the Nema size indicated on the drawings but shall be a minimum size one.
- C. Combination magnetic, full voltage starters for three phase motors shall be three pole horsepower rated, magnetically operated contacts, with three electronic overloads sized for the specific motors supplied. Overload "heaters" are not permitted. A three pole horsepower rated, fusible disconnect switch shall also be included integral within the enclosure. Provide fuses sized as recommended by the motor manufacturer. Starters shall be Allen-Bradley Bulletin 512, General Electric CR-308 or Square D Class 8538. Provide Hand-Off-Auto selector switch, pilot lights to indicate starter's position (Amber - Red - Green), a minimum of two normally open and two normally closed auxiliary contacts, control power transformer fused on primary and secondary, control coil, and three electronic overload relays with automatic reset. Select and provide overload relays that match the supplied motor requirements. Provide control power and coil voltage as required for interlock with the HVAC temperature control system and fire alarm system. Starters shall be the Nema size indicated on the drawings but shall be a minimum size one.
- D. Provide enclosure type suitable for the environment in which it is installed. Enclosure shall be interlocked so the door cannot be opened without turning the

unit off. This interlock shall be capable of being defeated by properly trained personnel.

- E. Provide phase failure relay for all three phase motors. Relay shall be fully adjustable to open the contacts when any phase to phase or phase to ground voltage is above or below 20% nominal. The relay drop out point shall be adjustable from 0% to 50%. Relay shall be provided with an adjustable time delay of 0 to 120 seconds before opening to avoid nuisance outages. Relay shall be full automatic to open and fully automatic to reset.
- F. Lighting contactors and other control contactors (i.e. fuel dispenser circuits) shall be NEMA type, electrically or mechanically held as indicated on the drawings. Provide control power and coil voltage as required for the indicated interlock. Square D Class 8903, or equal by GE, Siemens or Cutler Hammer.

PART 3 - EXECUTION

3.1 MOTOR CONTROLLERS, CONTACTORS AND ASSOCIATED CONTROLS

- A. Unless otherwise indicated, motor controllers shown on the drawings shall be furnished and installed under this section. The full load current and starting characteristics of each motor shall be verified for proper selection of motor over load devices. The Contractor shall furnish and install all steel shapes, etc., necessary for a support of all motor controllers.
- B. Unless otherwise indicated, all control devices, such as thermostats, firestats, etc., shall be installed in place and wired under other sections of the specifications. Coordinate required starter auxiliary contacts and coil voltages for a properly operational system.
- C. Motor controllers shall be installed in accordance with all applicable NEC installation requirements.

3.2 IDENTIFICATION OF EQUIPMENT

- A. Identification shall be provided for all motor controllers installed by the Contractor. Identification shall consist of white laminated plastic plates with black engraved letters.

END OF SECTION 26 29 13

SECTION 26 43 13 - SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes transient voltage surge suppressors for low-voltage (600Volts and below) power equipment
- B. Related Sections include the following:
 - 1. Division 26 Section "Wiring Devices" transient voltage surge suppressors.
 - 2. Division 26 Section "Panelboards"
 - 3. Division 26 Section "Switchboards"

1.3 SUBMITTALS

- A. Must have ten day prior approval to submit on project.
- B. Request for submittals must be in writing and attached with independent documentation of the following items.
- C. Drawings: Electrical and mechanical drawings shall be provided by the manufacturer which show unit dimensions, weights, mounting provisions, connection notes, wire size and wiring diagram.
 - 1. SPD's with dimensions that exceed the available space to mount the device within the required maximum lead lengths will be rejected and not accepted. Verify maximum lead lengths can be met prior to bid.
- D. Equipment Manual: The manufacturer shall furnish an installation manual with installation notes, start-up and operating instructions for the specified system. Installation instructions shall clearly state whether the system requires an external overcurrent device to maintain the system's UL 1449 listing. SPD requiring external overcurrent devices are not acceptable.
- E. Verification that all SPD are UL 1449 listed and rated with a 20kA (In) nominal discharge rating for compliance to UL96A Lightning Protection Master Label and NFPA 780. Also provide UL 1449 VPR showing the following maximum VPR (clamping voltage) as follows:
 - 1. 120Vsystem 600V (L-N)

2. 277V_{system} 1200V (L-N)

- F. SPD manufacturer shall provide UL 3rd Edition documentation as part of submittal.
- G. Manufacturer's Warranty Statement, showing a 10 year replacement warranty for modules or unit are damaged by transient voltages

1.4 STANDARDS

- A. Underwriters Laboratories 1449 - (UL 1449 4th edition safety standard for surge protection devices)
- B. NEC article 285. National Electrical Code 2011 SPD shall be labeled with a minimum 200kAIC rating.
- C. NFPA 780 Standard for the installation of lightning protection systems
- D. UL96A - Lightning Protection System Master Label
- E. IEEE (Institute of Electrical and Electronic Engineering Inc.) C62.41.1 and C62.41.2, IEEE C62.45, IEEE C62.33 & C62.35 – latest editions.
- F. All manufacturers must comply with above listed standards and any additions current revisions of industry standards. All products that do not comply with current industry standards will not be accepted.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

1.6 PROJECT CONDITIONS

- A. Placing into Service: Do not energize or connect service entrance equipment, panel boards, control terminals, or data terminals to their sources until the surge protective devices are installed and connected.
- B. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage (MCOV): Not less than 115 percent
 - 2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
 - 3. Humidity: 0 to 85 percent, non-condensing.
 - 4. Altitude: Less than 20,000 feet (6000 m) above sea level.

1.7 COORDINATION

- A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.
- B. Coordinate surge protective devices with Division 26 Section "Panelboards" and "Switchboards".

1.8 WARRANTY

- A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Manufacturer shall provide a product warranty for a period of not less than ten (10) years from date of installation. Warranty shall cover unlimited replacement of SPD modules during the warranty period. Those firms responding to this specification shall provide proof that they have been regularly engaged in the design, manufacturing and testing of SPD for not less than five (5) years.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. PQ Protection
- B. APT

2.2 SERVICE ENTRANCE SUPPRESSORS (TYPE SPD1)

Panel Amperage	≥3,000Amps	2500-1600Amps	1200-400Amps
Service Entrance	400kA/Modular	300kA/modular	200kA/modular

- A. Provide service entrance rated, UL Type 1 SPD's as shown and indicated on contract drawings.
- B. Minimum surge current ratings per phase shown above, three phase, wye systems per phase rating shall equal L-N and L-G modes added together. No other methods are acceptable for per phase surge current rating calculations.
- C. SPD's shall be a multi-stage parallel connected device.
- D. SPD's UL 1449 3rd Edition VPR (clamping voltage) shall be a maximum rating of:
 - 1. 120Vsystem 600V (L-N)

2. 277V_{system} 1200V (L-N)

- E. SPD's shall mount external to the panel; internally mounted SPD's are not acceptable.
- F. SPD voltages shall be verified by location on drawings, one-line diagrams and equipment schedules.
- G. SPD shall be modular design with field replaceable modules per phase and per mode.
- H. SPD shall have redundant status indicators on the front of the enclosure and shall monitor and indicate whether suppression capabilities have been compromised.
- I. SPD shall contain protective components that utilize multiple thermally protected metal oxide varistors (MOV) per mode.
- J. SPD's relying upon external and/or supplementary installed safety overcurrent protection do not meet the intent of this specification.
- K. SPD's that are limited to being connected to breaker whether or not an integral disconnect switch is supplied do not meet the intent of this specification.
- L. SPD's shall have an UL "In" rating (nominal discharge) of 20kA.
- M. SPD shall have dry contacts for remote monitoring via the Campus security system (Ademco panels). Coordinate the required contact type with the existing security panels.
- N. Service Entrance SPD's shall have audible alarms and surge counters.
- O. SPD's shall have a metal, NEMA 4 rated enclosure.
- P. SPD shall be designed and equipped with integral disconnecting means.
- Q. Protection modes: The SPD shall provide Line to Neutral (L-N) (Wye), Line to Ground (L-G) (Wye or Delta), Line to Line (L-L) (Delta) and Neutral to Ground (N-G) (Wye) protection.

2.3 DISTRIBUTION, BRANCH PANEL AND/OR AUXILIARY PANELS (TYPE SPD2)

Panel Amperage	1200-800A	600A	400-100A
Distribution	200kA	200kA	200kA
Branch Panels		100kA	100kA

- A. Provide UL Type 2 SPD's as shown and indicated on contract drawings. Any panel indicated to be 600 amp or larger, and any panel that is the service disconnect panel for the building shall be considered a "Distribution" type.
- B. SPD's minimum surge current ratings per phase shown above, three phase, wye systems per phase rating shall equal L-N and L-G modes added together. No other methods are acceptable for per phase surge current rating calculations.
- C. SPD's shall be a multi-stage parallel connected device.
- D. SPD's shall mount external to the panel; internally mounted SPD's are not acceptable.
- E. SPD voltages shall be verified by location on drawings, one-line diagrams and equipment schedules.
- F. SPD shall be a compact, non-modular design
- G. SPD shall have per phase status indicators on the front of the enclosure and shall monitor and indicate whether suppression capabilities have been compromised.
- H. SPD shall contain protective components that utilize multiple thermally protected metal oxide varistors (MOV) per mode.
- I. SPD's relying upon external and/or supplementary installed safety overcurrent protection do not meet the intent of this specification.
- J. SPD's shall have an UL "In" rating (nominal discharge) of 20kA.
- K. SPD shall have dry contacts for remote monitoring capabilities.
- L. SPD's shall have a metal, NEMA 4 rated enclosure
- M. Protection modes: The SPD shall provide Line to Neutral (L-N) (Wye), Line to Ground (L-G) (Wye or Delta), Line to Line (L-L) (Delta) and Neutral to Ground (N-G) (Wye) protection.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES

- A. Review all installation information in manufacturer's installation manual prior to installing SPD's.
- B. Verify all voltages before connecting to avoid injury and damage to equipment.
- C. The SPD's shall be installed external to switchboard, distribution and panelboard.
- D. Internally mounted SPD's will not be accepted.

- E. The service entrance/switchboard/switchgear SPD's shall be installed with the shortest lead length possible and shall avoid any unnecessary or sharp bends. SPD's shall be connected to breakers with a 30 amp, 3 pole breaker for connection means.
- F. The distribution, panelboard and auxiliary SPD's shall be installed with the shortest lead length possible from the panel it is protecting and shall avoid any unnecessary or sharp bends. SPD's shall be connected to breakers with a 30 amp, 3 pole breaker for connection means.
- G. Ground resistance shall be 5 Ohms or less.
- H. Refer to manufacturer's installation manual for further installation details.

3.2 FIELD QUALITY CONTROL

A INSTALLATION

- 1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with manufacturers' installation instruction requirements and recommendations.

B MANUFACTURERS FIELD SERVICE

- 1. Engage a factory authorized service representative to inspect equipment installation. Report results in writing
- 2. Verify that electrical wiring installation complies with manufacturer's installation requirements.

END OF SECTION 26 43 13

SECTION 26 51 19 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Division 26 Basic Electrical Materials and Methods section apply to work specified in this section.

1.2 DESCRIPTION OF WORK

- A. Extent of interior lighting luminaire work is indicated by drawings and schedules.
- B. Types of interior lighting luminaires in this section include the following:
 - 1. LED
- C. Applications of interior lighting luminaires required for project including the following:
 - 1. General lighting
 - 2. Supplementary lighting
 - 3. Task lighting
 - 4. Emergency lighting

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of interior lighting luminaires of types and ratings required, whose products have been in satisfactory use in similar service for not less than 10 years.
- B. Installer: Qualified with at least 10 years of successful installation experience on projects with interior lighting luminaire work similar to that required for project.
- C. NEC Compliance: Comply with NEC as applicable to installation and construction of interior building lighting luminaires.
- D. NEMA Compliance: Comply with applicable requirements of NEMA Std Pub Nos. LE 1 and LE 2 pertaining to lighting equipment.
- E. ANSI/IES Compliance: Comply with ANSI 132.1 pertaining to interior lighting luminaires.
- F. ANSI/UL Compliance: Comply with ANSI/UL standards pertaining to interior lighting luminaires for hazardous locations.
- G. UL Compliance: Provide interior lighting luminaires which have been UL-listed and labeled.

- H. CBM Labels: Provide fluorescent-lamp ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on interior building lighting luminaires, lamps and ballasts.
- B. Shop Drawings: Submit luminaire shop drawings in booklet form with separate sheet for each luminaire, assembled in luminaire "type" alphabetical order, with proposed luminaire and accessories clearly indicated on each sheet. Submit complete photometric data for each luminaire.
 - 1. All lamps shall be submitted for review with detailed performance data.
 - 2. All LED drivers shall be submitted for review with detailed performance data.
 - 3. Submit point-by-point photometric calculations for each interior typical area, including individual offices, open office, lobby, conference rooms, control room, corridor, storage room, etc.
 - 4. Sample luminaires shall be submitted if requested by the Owner or Architect-Engineer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with these requirements and the contract documents, provide luminaires as indicated on the luminaire schedule. Additional accessories, mounting hardware, options, etc., not specifically described but required for a properly operating and installed luminaire or as described by additional notation on the drawings or in the specifications, shall be provided. Substitutions are subject to Engineer approval. Submit a shop drawing submittal for prior approval of any and all substitutions.

2.2 INTERIOR LIGHTING LUMINAIRES

- A. General: Provide lighting luminaires, of sizes, types, and ratings indicated; complete with, but not necessarily limited to, housings, lamps, lamp holders, reflectors, ballasts, starters and wiring.
 - 1. LED luminaires shall be rated/tested to LM-79 standards.
- B. All drivers shall be fused or thermally protected with automatically resetting thermal overloads internal to the luminaire or driver. A quick disconnect or other means that meets the code shall be provided to disconnect the driver from power for service.

- C. LED Drivers: Provide drivers capable of operating lamp types provided with the luminaires; with high power factor, low-noise features and with internal thermal protection, class H insulation.
- D. Lamps: Provide lamps of the wattage and types specified on the drawings. Coordinate lamp type with driver for a complete operational, energy saving lighting system which will operate for the expected lamp and driver life.
 - 1. LED lamps shall produce the minimum lumens indicated at the color temperature specified and shall be tested/listed/rated in accordance with LM-80 as a minimum.
 - 2. Lamp and driver combinations shall have no noticeable flicker or delayed starting, including dimming driver combinations. Lamps shall start instantaneously and illuminate immediately. Any delay in starting or flickering or premature "off" will not be acceptable and the lamp and/or driver shall be replaced.

PART 3 - EXECUTION

3.1 INSTALLATION OF INTERIOR LIGHTING LUMINAIRES

- A. Install interior lighting luminaires at locations and heights as indicated, in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting luminaires fulfill requirements.
- B. Coordinate with other electrical work as appropriate to properly interface installation of interior lighting luminaires with other work.
- C. Fasten luminaires securely to building structural support; and ensure that pendant luminaires are plumb and level. Provide all required mounting hardware and steel channel to supplement structural support where necessary. Luminaires shall not be supported from ductwork, piping, conduits, ceiling grid or any other non-structural building member. Luminaires shall be supported at four corners or points on the luminaire.
- D. Coordinate luminaire installation with mechanical duct work, diffusers, return grilles, communication systems devices, etc., to avoid any interferences.

3.2 ADJUST AND CLEAN

- A. Clean interior lighting luminaires of dirt and debris upon completion of installation
- B. Protect installed luminaires from damage during remainder of construction period.

3.3 FIELD QUALITY CONTROL

- A. Upon completion of installation of interior lighting luminaires, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- B. At the time of Substantial Completion, replace interior lighting luminaires which are observed to be noticeably dimmed after Contractor's use and testing, as judged by Architect-Engineer.
- C. Commissioning: The project will be inspected and tested a by a commissioning agent. The interior lighting shall be performance tested by the Contractor as required by the commissioning agent. Any required test reports or documentation shall be provided.

3.4 GROUNDING

- A. Provide tight equipment grounding connections for each interior lighting luminaire installation.

3.5 WARRANTY

- A. All luminaires, LED lamps, and drivers shall be guaranteed against defective material and workmanship in accordance with the manufacturers published warranty for a minimum of five years from the date of the substantial completion. Longer standard manufactuer warranties shall be provided where standard. Warranty shall be published in the name of the Owner, not the Contractor.

END OF SECTION 26 51 19

SECTION 26 56 19 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Division-26 Basic Electrical Materials and Methods section apply to work specified in this section.

1.2 DESCRIPTION OF WORK

- A. Extent of exterior luminaire work is indicated by drawings and schedules.
- B. Types of exterior luminaires in this section include the following:
 - 1. LED
- C. Applications of exterior luminaires required for project including the following:
 - 1. Outdoor supplementary lighting

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of exterior luminaires of types and ratings required, whose products have been in satisfactory use in similar service for not less than 10 years.
- B. Installer: Qualified with at least 10 years of successful installation experience on projects with exterior luminaire work similar to that required for project.
- C. NEC Compliance: Comply with NEC as applicable to installation and construction of exterior building luminaires.
- D. UL Compliance: Provide exterior luminaires which are UL-listed and labeled.
- E. CBM Labels: Provide ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on exterior luminaires, lamps, and ballasts.
- B. Shop Drawings: Submit dimensioned drawings of exterior luminaire. Submit fixture shop drawings in booklet form with separate sheet for each fixture, assembled in luminaire "type" alphabetical order, with proposed fixture and accessories clearly indicated on each sheet. Provide photometric data for each fixture type. Clearly indicate fixture lamp and ballast type and manufacturer.

1. All lamps shall be submitted for review with detailed performance data.
2. All ballasts/drivers shall be submitted for review with detailed performance data.
3. Submit point-by-point photometric calculations for each exterior area, including parking, drives, property line, walkways and entrances. Calculations shall use a 0.91 light loss factor and shall be assembled by area.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with these requirements and the contract documents, provide luminaires as indicated on the luminaire schedule. Additional accessories, mounting hardware, options, etc., not specifically described but required for a properly operating and installed luminaire or as described by additional notation on the drawings or in the specifications, shall be provided. Substitutions are subject to Engineer approval. Submit a shop drawing submittal for prior approval of any and all substitutions.

2.2 EXTERIOR LUMINAIRES

- A. General: Provide luminaires, of sizes, types, and ratings indicated; complete with, but not necessarily limited to, housings, lamps, lamp holders, reflectors, ballasts, starters and wiring.
 1. LED light luminaires shall be rated/tested to LM-79 standards.
- B. All drivers shall be thermally protected with automatically resetting thermal overloads internal to the luminaire or driver.
- C. LED Drivers: Provide drivers capable of operating lamp types provided with the luminaires; with high power factor, low-noise features and with internal thermal protection, class H insulation.
- D. Lamps: Provide lamps of the wattage and types specified on the drawings. Coordinate lamp type with driver for a complete operational, energy saving lighting system which will operate for the expected lamp and driver life.
 1. LED lamps shall produce the minimum lumens indicated at the color temperature specified and shall be tested/listed/rated in accordance with LM-80 as a minimum.
 2. Lamp and driver combinations shall have no noticeable flicker or delayed starting, including dimming driver combinations. Lamps shall start

instantaneously and illuminate immediately. Any delay in starting will not be acceptable and the lamp and/or driver shall be replaced.

PART 3 - EXECUTION

3.1 INSTALLATION OF EXTERIOR LUMINAIRES

- A. Install exterior luminaires at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that luminaires fulfill requirements.
- B. Coordinate with other electrical work as appropriate to properly interface installation of exterior luminaires with other work.
- C. Fasten luminaires securely to required structural supports; and check to ensure that solid pendant luminaires are plumb.

3.2 ADJUST AND CLEAN

- A. Clean exterior luminaires of dirt and debris upon completion of installation.
- B. Protect installed luminaires from damage during remainder of construction period.

3.3 FIELD QUALITY CONTROL

- A. Upon completion of installation of exterior luminaires, and after building circuitry, apply electrical energy to luminaires to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- B. At the time of Substantial Completion, replace lamps in exterior luminaires which are observed to be noticeably dimmed after Contractor's use and testing, as judged by Architect-Engineer.
- C. Commissioning: The project will be inspected and tested by a commissioning agent. The interior lighting shall be performance tested by the Contractor as required by the commissioning agent. Any required test reports or documentation shall be provided.

3.4 GROUNDING

- A. Provide tight equipment grounding connections for each exterior luminaire installation.

3.5 WARRANTY

- A. All luminaires, LED lamps and drivers shall be guaranteed against defective material and workmanship in accordance with the manufacturers published warranty for a minimum of five years from the date of the substantial completion. Longer standard manufacturer warranties shall be provided where standard. Warranty shall be published in the name of the Owner, not the Contractor.

END OF SECTION 26 56 19

SECTION 28 31 11 – DIGITAL ADDRESSABLE FIRE ALARM SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other related specification sections, apply to work of this section.

1.2 SECTION INCLUDES

- A. Modifications to existing addressable fire alarm and smoke detection and supervisory system.

1.3 REFERENCES (FIRE ALARM SHALL COMPLY WITH THE FOLLOWING)

- A. 5th Edition of the Florida Fire Prevention Code including NFPA 101 - Code for Safety to Life from Fire to Buildings and Structures, Florida Specific Edition.
- B. 5th Edition of the Florida Building Code (2014).
- C. NFPA 70 - National Electrical Code, 2011
- D. NFPA 72 - National Fire Alarm Code, 2013.
- E. NFPA-2001 – Standard on Clean Agent Fire Extinguishing Systems, 2012
- G. Refer to Specification Sections 21 2200 and 21 0000

1.4 REGULATORY REQUIREMENTS

- A. System: UL listed.
- B. Conform to requirements of the Florida Fire Prevention Code and the State Fire Marshall.

1.5 DESCRIPTION OF SYSTEM

- A. The system shall be an addressable, microprocessor based fire alarm control system with transient protection on each circuit and walk-through test capability. Modify and expand the existing system as necessary to add the new devices, alarms, and controls.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in smoke detection and fire alarm systems with twenty (20) years documented experience.

- B. Installer: Company specializing in smoke detection and fire alarm systems with ten (10) years documented experience with projects of equivalent scope of work and size and certified by the Florida State Licensing Board as fire alarm installing contractor. The actual installer shall be licensed in Florida to install fire alarm systems and shall be certified by the system manufacturer to install the system. Proof of certification and licensure shall be provided upon request.

1.7 SUBMITTALS

- A. Submit six (6) copies shop drawings and product data.
- B. Provide complete point to point wiring diagrams, data sheets, and equipment ratings, layout, dimensions, and finishes. Indicate the location of surge protection devices.
- C. Submit manufacturer's installation instructions.
- D. Submit manufacturer's certificate that the system meets or exceeds specified requirements - certification per NFPA 72.
- E. Submit copy of Contractor's license before work begins.
- F. Submit battery calculations indicating the required battery, including the specified spare capacity for the expended system.
- G. Submit voltage drop calculations.
- H. Provide training for four (4) people on the operation, maintenance, and repair of the system modifications at the Contractor's expense.

1.8 PROJECT RECORD DRAWINGS

- A. Contractor shall provide five (5) sets of as-built drawings to the Owner upon completion of project.
- B. As-builts shall include the location of end-of-line devices, surge protection devices and exact conduit and wire routing. Numbers and types of conductors shall be indicated for each circuit.

1.9 OPERATION AND MAINTENANCE DATA

- A. Provide seven (7) copies of operation and maintenance data prior at the completion of construction for all point devices, CPUs, and all other equipment.
- B. Include operating instructions, and maintenance and repair procedures.
- C. Provide manufacturer representative's letter stating that the system is operational.

- D. Provide a CD with a copy of the final programming, including any software access codes necessary for the Owner to access the required program for maintenance using authorized personnel.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Products shall be delivered to job site in manufacturers original shipping packages.
- B. Provide storage and protection of products, as needed.

1.11 SPECIAL REQUIREMENTS

- A. The Fire Alarm System herein specified shall be furnished by a manufacturer of Fire Alarm Systems who has been conducting business in the general Seminole County area for at least five (5) years. A complete stock of parts for the systems furnished shall be in inventory at the facilities of the supplier. The equipment manufacturer shall have service facilities within a one hundred (120) mile radius of the building with parts in stock and trained service personnel and shall respond to a service call within twenty-four (24) hours after request during the warranty period (four (4) hours for an emergency request).
- B. Installation to be performed only by Manufacturer's authorized, trained, and licensed installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Siemens is the existing fire alarm control panel. All new devices and new work shall be compatible with and listed for use with the existing control panel.

NOTE: Manufacturer's equipment shall meet all code requirements and performance criteria as outlined in the contract documents, including all code requirements.

2.2 FIRE ALARM CONTROL PANEL (FACP)

- A. Expand and modify the existing control panel for all of the new devices, controls and alarms.

- 1. Update any annunciator panels for the new work.

2.3 INITIATION DEVICES AND ACCESSORIES – ADDRESSABLE (WHERE APPLICABLE)

- A. Manual Pull Station: Semi-flush mounted, supervised, normally open single action, addressable type manual pull station. Manual stations shall be single

action and shall be constructed of impact resistant lexan with raised white lettering and a smooth high gloss finish. The station shall have a hinged front with key lock. Stations which utilize screwdrivers, Allen wrenches, or other commonly available tools shall not be accepted. Stations shall be keyed alike with the fire alarm control panel. When the station is operated, the handle shall lock in a protruding manner to facilitate quick visual identification of the activated station.

- B. Heat Detector: Easy installation, low profile with wide base to cover mounting plate and box. Detectors shall be white and shall be self-restoring operation. Detectors shall be a combination rate of rise/fixed temperature with thermostats rated at 135 degrees F, except when the plans call for a 194 or 200 degrees F rating (HT). Rate of rise setting shall be selectable at either 15 degrees F per minute or 20 degrees F per minute, factory set at 15 degrees F. The detector shall be the addressable type for use with an addressable system and shall be UL 521 listed for this purpose.
 - 1. Heat detectors installed in hazardous environments shall be the explosion proof type.
- C. Smoke Detectors: NFPA 72; photoelectric type with plug-in base, supervised visual indication of detector actuation, suitable for mounting on four inch (4") outlet box.
 - 1. Detectors shall be listed to U.L. Standard 268 and shall be documented compatible with the control equipment to which it is connected. Detectors shall be listed for this purpose by Underwriters Laboratories, Inc. The detectors shall obtain their operating power from the fire alarm panel supervised detection loop. The operating voltage shall be 24 VDC (nominal). Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal to be generated at the control panel. Detectors shall be the addressable type for use on an addressable type system.
 - 2. Each detector shall have a flashing status indicating LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady and at full brilliance. The detector may be reset by actuating the control panel reset switch.
 - 3. To minimize nuisance alarms, voltage, EMI and RF transient suppression techniques shall be employed as-well-as a smoke verification circuit and an insect screen. The detector design shall provide full solid-state construction and compatibility with other normally open fire alarm detection loop devices (heat detectors, pull stations, etc.). The detector head shall be easily disassembled to facilitate cleaning.

4. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog intelligent smoke detectors in the system from the System keypad or from the keyboard of the video terminal. Sensitivity range shall be within the allowed UL window. The detector shall employ automatic environmental compensation.
 5. Alarm Verification: Each of the Intelligent/Addressable Smoke Detectors in the system may be independently selected and enabled to be an alarm verified detector. The Alarm Verification Function shall be programmable from 5 to 50 seconds and each detector shall be able to be selected for verification during the field programming of the system, or anytime after system turn-on. The Alarm Verification shall not require any additional hardware to be added to the Fire Alarm Control Panel. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
- D. Duct Mounted Smoke Detectors: Duct mounted smoke detectors shall be of the solid state photoelectric type and shall operate on the light scattering photodiode principle. The detectors shall be the same as the smoke detectors described in Section 2.03, C., above. Detectors shall be 4 wire operation, addressable type for use on an addressable type system. The detectors shall be mounted in a duct housing with an integral red LED which shall pulse continuously to indicate power on and glow continuously to indicate alarm or sensor trouble condition. The detectors shall be designed to ignore invisible airborne particles or smoke densities that are below the factory set alarm point. No radioactive materials shall be used. Detectors shall be provided with the capability of performing automatic fan shutdown either directly from the detector or via the main control panel.
1. Provide a remote alarm indicator for each duct mounted smoke detector.
 2. Provide a sampling tube sized for the required duct width and rated for the air velocity present in the duct.
 3. Provide control relays and control circuit for air handler shutdown.
 4. Provide detectors in supply and return air streams of each air handler over 2,000 cfm.

2.4 INDICATING APPLIANCES AND ACCESSORIES (WHERE APPLICABLE)

- A. Speakers/Horns: Where indicated on the drawings provide moisture repellent, fire retardant horn/speaker designed for smooth frequency response with minimal distortion. Speakers shall be listed and approved for use as a fire alarm indicating appliance. Speakers shall all sound the same general alarm and shall meet all NFPA requirements. Outdoor speakers shall be weatherproof, installed in a weatherproof outlet box, and listed for use as an outdoor fire alarm indicating appliance.

1. Sound Level: 87 dB at 10 feet not to exceed 120 dB. Provide higher dB levels if necessary for the ambient noise level.
 2. Provide speakers throughout the facility to provide for audibility, as required to meet NFPA.
 3. Speaker enclosures shall be white in color.
- B. Visual Flashing Lamps (Xenon Strobe): Visual indicating appliances shall be comprised of xenon flashtube and be entirely solid state. These devices shall be UL listed and be capable of either ceiling or wall mounting. The lexan lens shall be pyramidal in shape to allow better visibility. Separate alarm indicating circuits shall be provided for strobes. The maximum strobe pulse duration shall be 0.2 seconds with a maximum duty cycle of 40 percent. The intensity shall be selected to meet the NFPA requirements and the flash rate shall be at least 1 Hz but not to exceed 3 Hz. In all cases strobe must meet current Department of Justice's Americans with Disabilities Act (ADA) Standards for Accessibility (ADAS) and NFPA requirements. Provide synchronized strobes where required by NFPA-72.
1. Strobe enclosures shall be white in color.
- C. Audio/Visual Alarm Indicating Appliance: Audio/Visual units shall provide a common enclosure for the fire alarm audible and visual alarm devices. The housing shall be designed to accommodate either horns, bells, chimes, or speakers. The unit shall be complete with a tamper resistant, pyramidal shaped lexan lens with "Fire" lettering visible from a 180 degree field of view. The front panel or bezel which is constructed of cast metal maybe inverted so that the lens is below the audible device. The lamp assembly shall incorporate a built-in reflector for more efficient light propagation and a special shock-mounting arrangement to resist Bulb failure due to vibration. Lamp shall be provided with a 4 wire connection to insure properly supervised in/out system connection. Unit shall be complete with all mounting hardware including backbox. Audio/Visual unit shall be UL Listed for its intended purpose. The audible appliance and visual flashing lamps shall meet the specification indicated above in Parts A and B.
1. Combination speaker/strobes shall be white in color.

2.5 MISCELLANEOUS DEVICES AND ACCESSORIES

- A. Relays and Control Modules for auxiliary control: Provide auxiliary control relays or control modules for door release, end of line supervision and other required control functions indicated on the drawings or otherwise specified. All auxiliary control circuits shall be indicated on the annunciator as a separate zone or shall be addressable using a monitor module so the device can be identified quickly and accurately.
- B. Monitor Module (Individual Addressable Module)

1. Addressable Monitor modules shall be provided to connect one supervised circuit of a conventional alarm or trouble initiating device (any N.O. dry contact device), such as tamper switches and water flow switches, etc., to the Fire Alarm Control Panel.
 2. The Monitor Module shall mount in a 4-inch square, 2-1/8" deep electrical box.
 3. The conventional alarm initiating device may be wired for Style D or Style B operation. The Monitor module shall provide address-setting means using decimal switches and shall also store an internal identifying code that the Fire Alarm Control Panel shall use to identify the type of device. Modules that use binary jumpers or dip-switches are subject to installation errors are not acceptable. An LED shall be provided that shall flash under normal conditions, indicating that the Monitor module is operational and in regular communication with the control panel.
 4. For difficult to reach areas, the Monitor Module shall be available in a miniature package and shall be no larger than 2-3/4" x 1-1/4" x 1/2". This version need not include Style D or an LED.
- C. Provide for fire/smoke damper control for dampers added in the lobby.
- D. Provide supervised monitoring circuits of all sprinkler system water flow switches and tamper switches.
1. Provide valve tamper switch monitoring circuit on the exterior fire protection system backflow assembly on the site. Provide surge suppression device on this circuit.
- E. Connections to security system access controls: Provide the necessary circuits and controls to release access controlled doors where required by NFPA. Coordinate requirements with the access control system for the control circuit location and connections. Coordinate with door hardware specifications.
- F. Provide all required monitoring, supervision and controls for all of the clean agent fire suppression systems. Refer to clean agent system specifications for coordination of smoke detector requirements, and control requirements.

2.6 BATTERY BACK-UP

- A. The system shall be battery back-up for 24 hours plus five (5) minutes of alarm capabilities after a 24 hour standby period (per NFPA 72) with all system indicating appliances operating, including strobes, plus 30% spare capacity. Batteries shall be completely sealed, rechargeable type and maintenance free. Expand existing batteries are required.

2.7 LIGHTNING PROTECTION

- A. Provide surge suppression devices on each initiating device loop and each indicating appliance circuit, for any new circuits.
- C. All lightning protection shall be manufactured and listed for use with the fire alarm system by the fire alarm system manufacturer. Devices shall be terminal strip mounted and shall be mounted in a terminal cabinet separate from the control panel, as required to meet UL requirements.
- D. Lightning protection devices shall be UL listed. The clamping voltage shall be coordinated with the system voltage to avoid nuisance clamping. Devices found to clamp too quickly shall be replaced.

2.8 DIGITAL ALARM COMMUNICATOR TRANSMITTER (DACT)

- A. Existing to remain.

2.9 FIRE ALARM CABLE

- A. All fire alarm conductors shall meet the requirements of the local fire marshal and the National Electrical Code. All conductors shall be installed in conduit.
- B. Underground fire alarm circuit are not permitted, except for the circuit to the backflow preventer. This cabling shall be rated for underground, water-tight use and be an “aqua-seal” type cable.

2.10 CLEAN AGENT FIRE SUPPRESSION

- A. Provide all required control and monitoring interface with the clean agent fire suppression system. Refer to specification 21 2200 and provide all required power, fire alarm wiring, and fire alarm control. Provide control of all dampers as required to close and seal the room in alarm. Provide indication of all supervisory, trouble, and alarm signals from the clean agent panels.
- B. Monitor the clean agent panels for alarm, trouble, and supervisory. All smoke detection (smoke detectors) in the clean agent space shall be provided as a part of the clean agent system, per specification 21 2200, with the exception of the fire alarm system smoke detector above the clean agent panel. Provide the smoke detector above the clean agent control panel.

PART 3 - SEQUENCE OF OPERATION

3.1 ENTIRE BUILDING

- A. Update and modify the existing control and sequence programming to add all of the new devices and monitoring, including the clean agent system, and the smoke damper monitoring and controls.

- B. Clean agent panels shall initiate a supervisory alarm at the FACP when a clean agent system is in alarm mode or trouble mode. Provisions shall be made to re-program clean agent alarm to sound the building alarm, if required by the AHJ.
- C. Provide all additional control functions required by Florida Building Code and the Florida Fire Prevention Code.

PART 4 - PROGRAMMING

- 4.1 The system shall be fully programmed and completely operational prior to acceptance. The FACP and CPU shall have the capability to be fully programmable by Owner's personnel or Owner's separate vendor under contract to maintain the system. Provide all necessary software access to the owner for re-programming by the owner. Provide all required programming and re-programming for all inspections and final acceptance by the owner, engineer, and fire marshal at no additional cost to the owner, including revisions and modifications to the sequences.
- 4.2 The Manufacturer shall provide the necessary documentation and training to allow the Owner's personnel to maintain and change software.
- 4.3 Program data shall be stored in non-volatile memory with battery back-up. Program data shall not be lost due to temporary outages, surges, dips, etc.

PART 5 - EXECUTION

5.1 INSTALLATION OF FIRE ALARM AND DETECTION SYSTEMS

- A. Install fire alarm and detection systems as indicated, in accordance with equipment manufacturer's written instructions and complying with applicable portions of NEC and NECAs "Standard of Installation" and NFPA-72.
- B. Wiring Systems and Materials
 - 1. Wiring shall be in accordance with requirements of the National Electrical Code and NFPA Regulation 72. The fire alarm system, including components, conduit, boxes and wiring shall be completely installed and wiring and conduit shall be properly tagged and color coded. The Electrical Contractor shall make final connections as shown and required by the equipment manufacturer's wiring instructions.
 - 2. Wiring shall be color coded to match existing.
- D. All wire shall be terminated with crimp type open-end spade lugs using tool approved by plug manufacturer. Wire terminating at the control panel or terminal cabinets shall be identified as to circuit and use.
- E. Wiring run to terminal cabinets shall terminate on barrier-type terminal strips. Wire nuts are not acceptable.

- E. All wiring to be installed in conduit with continuous ground. Free-wired cabling is not permitted. Conduit shall be spot painted red and all junction boxes shall be painted red.
- F. All junction box covers shall be painted red. All lengths of conduits shall have at least one red stripe.
- G. AHU shutdown relays and equipment control relays shall be mounted within three (3) feet of controlled device. AHU shutdown relays shall be wired on a separate circuit.
- H. Visual flashing lamps and speakers shall be wired on alternate circuits to provide coverage in the event of the failure of one circuit. Provide the required number of circuits for the indicated number of alarm indicating devices.
- I. Provide conduit, wire and circuit breakers to connect fire alarm control panels to a dedicated circuit. The fire alarm circuit breaker shall be accessible to authorized personnel only and shall be marked FIRE ALARM CIRCUIT CONTROL. Provide handle lock for circuit breaker handle. Paint the handle tie red.

5.2 QUALITY ASSURANCE

- A. NEC Compliance comply with NEC as applicable to construction and installation of fire alarm and detection system components and accessories.
- B. UL Compliance and Labeling - Provide fire alarm and detection system components which are UL listed and labeled. Installation is to be by a UL listed installer.
- C. Misc. compliance - The fire alarm system is to be installed in accordance with the equipment manufacturer's written instructions and comply with all applicable portions of the NECAs "Standard Installation" and all local codes and ordinances.

5.3 FIELD QUALITY CONTROL

- A. Inspect relays and signals for malfunctioning, and where necessary adjust units for proper operation to fulfill project requirements. Any fine adjustment shall be performed by specially trained personnel in direct employ of manufacturer of the fire alarm detection system equipment. The Manufacturer's representative shall perform a quality inspection off the final installation and, in the presence of the Electrical Contractor, Architect-Engineer, and Owner's Representatives, shall perform a complete functional test of the system. A system certification verifying the proper system operation shall be required prior to acceptance by the Owner.

5.4 SYSTEM GUARANTEE

- A. All components, parts, and assemblies supplied by the Manufacturer shall be guaranteed against defects in materials and workmanship for a period of twelve

(12) months commencing the date of substantial completion. Warranty service shall be provided by a qualified factory trained representative of the equipment manufacturer. Service response time shall be a maximum of four (4) hours before arrival to site.

B. Testing: The Contractor shall perform all electrical and mechanical tests required by the equipment manufacturer's form and National Fire Protection Association - 72. All test and report costs shall be in the contract price. A checkout report shall be prepared by the installation technicians and submitted in triplicate, one (1) copy of which will be registered with the equipment manufacturer. The report shall include, but not be limited to:

1. A complete list of equipment installed and wired.
2. Indication that all equipment is properly installed and functions and conforms with these specifications.
3. Test result of individual initiating devices and indicating appliances.
4. Serial numbers, locations by zone and model number for each installed detector.
5. Response time on thermostats and flame detectors (if used).
6. Technician's name, certificate number and date.
7. System will not be accepted until this certification is received.

C. Documentation: After completion of the tests and adjustments listed above, the Contractor shall submit the following information to the Owner.

1. A copy of the test report described in this specification and a Certificate of Compliance prepared as per National Fire Protection Association Standard 72, and State Fire Marshal's Rule 4A-48 to be complete at final test.
2. Affixed to FACP a standard service tag, as described in rule 4A-48 for fire alarm contractors by the Office of the State Fire Marshal.
3. Final tests and inspection shall be held in presence of the Owners' representatives and to their satisfaction. The Contractor shall supply personnel and required auxiliary equipment for this test without additional cost to the Owner.
4. To assure that wire size, power supply, number of devices on a circuit, etc. are suitable to support 100% of devices being in alarm or operated simultaneously, this test shall include the following:

- a. Place all sensors and monitor modules in alarm. Each shall display it's address and alarm condition. At least the first ten (10) devices on each circuit shall also have their alarm LEDs lighted.
- b. Operate all control modules for the alarm or operated condition. Each module shall display it's address and condition.
- c. Reset all alarmed and operated devices. The panel shall display the address or zone of any off-normal devices.
- d. Test a representative number of sensors for alarm verification by momentarily testing for alarm. The sensor shall not initiate an alarm. Then, test by placing the sensor in alarm such that it remains in alarm for the selected verification time. The sensor shall initiate an alarm.
- e. Acceptance of the system shall also require a demonstration of the stability of the system. This shall be adequately demonstrated if the system operates for a ninety (90) day test period without any unwarranted alarms. Should unwarranted alarm(s) occur, the Contractor shall readjust or replace the detector(s) and begin another ninety (90) day test period. As required by the Architect-Engineer the Contractor shall recheck the detectors using the fire test after each readjustment or replacement of detectors. This test shall not start until the Owner has obtained beneficial use of the building under tests.
- f. If the requirements provided in the paragraph above are not completed within thirty (30) days after beginning the tests described therein, the Contractor shall replace the system with another acceptable manufacturer and the process repeated until acceptance of the equipment by the Owner.
- g. Before final acceptance of work; the Contractor shall deliver seven (7) copies of a composite "Operating and Shop Maintenance Manual." Each manual shall contain, but not be limited to:
- h. A statement of guarantee including date of termination and name and phone number of the person to be called in the event of equipment failure.
- i. Individual factory issued manuals containing all technical information on each piece of equipment installed. In the event that such manuals are not obtainable from the factory, it shall be the responsibility of the Contractor to compile and include them. Advertising brochures or operational instructions shall not be used in lieu of the required technical manuals.

- j. One (1) copy of all approved shop drawings, instruction sheets, operating instructions, and spare parts bulletins.
 - k. A training session, for personnel selected by the Owner, shall be presented by a fully qualified, trained representative of the equipment manufacturer who is thoroughly knowledgeable of the specific installation.
 - l. Provide a written description of standard control panel functions and user instructions at each FACP. These instructions shall be written in standard laymen's English so that an unfamiliar operator can accomplish basic functions such as reset.
- E. Warranty: All equipment and systems shall be warranted by the Contractor for a period of one (1) year following the date of final acceptance. The warranty shall include parts, labor, prompt field service, pick-up, and delivery.
- 1. At the end of the one year warranty, provide testing as per National Fire Protection Association 72, which shall consist of: Provide a Test and Written report which certify that all initiating devices have been tested and which indicate the result of the inspection. Provide the required certification tag. Problems discovered during this testing and inspection shall be covered under the warranty. It is the contractor's responsibility to perform this testing prior to the end of the one year warranty or provide an extended warranty if the test is performed after the warranty period was scheduled to expire.

END OF SECTION 28 31 11

