

MECHANICAL
ELECTRICAL
PLUMBING
FIRE PROTECTION
TELECOMMUNICATIONS

LOKEY NISSAN CLEARWATER, FL

100% Construction Documents Mechanical & Electrical Specifications

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APG Engineering Project # 2151



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SECTION 23 0500
COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Common work results for requirements specifically applicable to Division 23.
- B. Requirements of Division 01 Specifications, General Provisions of the Contract and General and Supplementary Conditions apply to this Division.

1.02 REFERENCES

- A. ANSI: American National Standards Institute.
- B. ARI: American Refrigeration Institute.
- C. ASHRAE: American Society of Heating Refrigeration and Air Conditioning Engineers.
- D. ASME: American Society of Mechanical Engineers.
- E. ASTM: American Society for Testing and Materials.
- F. AWWA: American Water Works Association.
- G. FM: Factory Mutual.
- H. IRI: Industrial Risk Insurers.
- I. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry.
- J. NEMA: National Electrical Manufacturers Association.
- K. NFPA: National Fire Protection Association.
- L. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.
- M. UL: Underwriters' Laboratories, Inc.
- N. UL Fire Resistance Directory
- O. ASTM E814-13a: Standard Test Method for Fire Tests of Penetration Firestop Systems.

1.03 RELATED REQUIREMENTS

- A. Section 01 1000 - Summary: Contract descriptions, description of alterations work, work by others, future work, occupancy conditions, use of site and premises, work sequence.
- B. Section 01 2000 - Price and Payment Procedures: Applications for payment, Schedule of Values, modifications procedures, closeout procedures.
- C. Section 01 3000 - Administrative Requirements: Submittal procedures, project meetings, progress schedules and documentation, reports, coordination.
- D. Section 01 6000 - Product Requirements: Fundamental product requirements, substitutions and product options, delivery, storage, and handling.
- E. Section 01 7000 - Execution Requirements: Examination, preparation, and general installation procedures; preinstallation meetings; cutting and patching; cleaning and protection; starting of systems; demonstration and instruction; closeout procedures except payment procedures; requirements for alterations work.
- F. Section 01 7800 - Closeout Submittals: Project record documents, operation and maintenance (O&M) data, warranties and bonds.
- G. Section 01 7900 - Demonstration and Training: Detailed requirements.
- H. Section 02 4100 - Demolition: Selective demolition, site demolition, structure removal.

1.04 REFERENCE STANDARDS

- A. Perform work specified in Division 23 in accordance with standards listed below of the latest applicable edition adopted by the authority having jurisdiction. Where these Specifications are

more stringent, they shall take precedence. In case of conflict, obtain a decision from the Engineer of Record.

1. ICC/ANSI A117.1: Accessible and Usable Buildings and Facilities.
 2. Florida Building Code, 2010 with 2012 supplements.
 3. IBC: International Building Code, with Mechanical and Plumbing Codes.
 4. NFPA 30: Flammable and Combustible Liquids Code (2008)
 5. NFPA 70: National Electrical Code (2008)
 6. NFPA 72: National Fire Alarm Code (2007)
 7. NFPA 90A: Standard for the Installation of Air-Conditioning and Ventilating Systems (2009)
 8. NFPA 90B: Standard for the Installation of Warm Heating and Air-Conditioning Systems (2009)
 9. NFPA 101: Life Safety Code (2012)
 10. NFPA 241: Standard for Safeguarding Construction, Alteration, and Demolition Operations (2004)
 11. Special regulations, supplement, and amendments of the State and/or local authorities having jurisdiction.
- B. Comply with the applicable edition date of each regulation as adopted by the authorities having jurisdiction.

1.05 PROJECT/SITE CONDITIONS

- A. Layouts indicated on drawings are diagrammatic and intended to show relative positions and arrangement of equipment of equipment and ductwork. Coordinate mechanical work with other trades and measurements obtained at the job site, as applicable, prior to installation. Generally, install work in locations shown on Drawings, using as necessary, rises, drops, offsets, transitions, and alternate routings to fit in the available space unless prevented by Project conditions.
- B. If prevented by project conditions, prepare drawings showing proposed rearrangement of Work, including changes to Work specified in other sections. Obtain permission of Engineer of Record before proceeding.
- C. Cause as little interference or interruption of existing utilities and services as possible. Schedule work which will cause interference or interruption in advance with Owner, authorities having jurisdiction, and all affected trades.
- D. Determine sizes and verify locations of existing utilities on or near site.
- E. Keep roads clear of materials and debris.
- F. Visit site and be informed of conditions under which Work must be performed.
- G. Locate equipment requiring periodic serving so that it is readily accessible. Provide means of service access, following appropriate manufacturer's recommended service clearance space or, as applicable, means of access using duct, wall, or ceiling access doors.
- H. Install ductwork and piping to leave sufficient space for AHJ inspection of wall construction.

1.06 FEES AND PERMITS

- A. Obtain and pay for all necessary permits and inspection fees required to perform Division 23 work.

1.07 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Incomplete submittals containing unmarked cutsheets or not providing specific detail of what is being proposed will be rejected and will not be reviewed.
- C. Include Products as specified in the individual sections of Division 23.
- D. Submit shop drawing and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.

- E. Prepare shop drawings completely independent of the Engineer of Record's CADD files. Should the Contractor or Vendor wish to use the Engineer of Record's CADD files as the basis for developing their shop drawings, a release form, obtainable from the Engineer or Architect, must be signed and a nominal charge per sheet as determined on a per project basis must be made payable to APG Engineering to cover the cost of preparing the drawings for use by others.
- F. Brochures: Submit manufacturer's product data and brochures including:
 - 1. Complete descriptions.
 - 2. Illustrations.
 - 3. Rating data, accessories, dimensional data, and applicable options and features marked for the specific items scheduled on drawings and specified herein.
 - 4. Capacities stated in the terms specified.
 - 5. Performance curves for all air handling units, fans, and pumps.
 - 6. Performance data for all air terminal devices including but not limited to grilles, registers, and diffusers.

1.08 COORDINATION DRAWINGS

- A. Prior to commencement of installation, prepare coordination drawings for work under this division, as specified in Division 01, in full cooperation with persons performing work under other Divisions, including but not limited to mechanical, electrical, plumbing, fire protection, telecommunications, audio/visual and miscellaneous steel.
- B. Drawings shall not be formally submitted but shall be kept on site for reference. Notify Engineer of Record and Construction Manager of conflicts that cannot be resolved.
- C. Coordination Drawings shall be prepared to include the following:
 - 1. Drawn to scale of 1/4" = 1'-0".
 - 2. Room dimensions.
 - 3. Sheet size matching contract documents.
 - 4. Duct sizes with bottom elevation from finished floor.
 - 5. Show equipment, columns, and beams.
 - 6. Duct fitting details.
 - 7. Construction details of plenums and casings.
 - 8. Concrete pad and foundation layouts including anchor bolt and sleeve locations.
 - 9. Dimensioned floor drain locations.
 - 10. Wall mounted equipment.
 - 11. Piping three inches and larger, with elevations from finished floor to bottom of pipe.
 - 12. Space allocation for conduits and cable trays.
 - 13. Ceiling height.
 - 14. Ductwork, air terminal units, and piping three inches and larger shall be shown in proper graphic scale.

1.09 COMPLETENESS OF WORK

- A. The Contract Documents depict HVAC systems which are intended to be complete and functioning systems. All products, materials, and labor necessary to render a fully functional system to fulfill the design intent shown on the documents shall be provided by the Contractor.
- B. Catalog numbers referenced throughout the Division 23 Drawings and Specifications are intended to convey a general understanding of the type and quality of the product required. Where written descriptions differ from information conveyed by a catalog number, the written description shall govern. No extra shall be allowed because a catalog number is found to be incomplete or obsolete.

1.10 REFERENCE STANDARDS AND DEFINITIONS.

- A. Comply with provisions of Division 01.

1.11 PRODUCT SUBSTITUTIONS

- A. Comply with provisions of Division 01.

1.12 RECORD DRAWINGS

- A. Provide record drawings that illustrate the work of Division 23 as finally constructed. Deliver record drawings to the Engineer of Record in electronic format and also three (3) hard copies marked in red ink to reflect work as constructed.
- B. Record drawings shall reflect all changes made to the Contract Documents, whether generated by addenda, change orders, or field conditions. Maintain a daily record of these changes and keep current set of drawings showing these changes.
- C. Deliver record drawings to Engineer of Record within 30 days of Substantial Completion.
- D. Coordination drawings are to indicate air terminal units, fan coil units, air handling units, fans, control panels, and all other devices and materials to proper scale.

1.13 OWNING AND OPERATING MANUALS

- A. Comply with requirements of Division 01, but provide a minimum of three hard copy sets and electronic copy.
- B. Manuals shall include clear and comprehensive instructions with appropriate graphics and project specific marked data to enable Owner to operate and maintain all systems specified in this Division.
- C. Copies of final reviewed submittals indicating all model numbers, serial numbers, cut sheets, and all performance criteria on furnished equipment shall be included.

1.14 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.
- C. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.15 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 EQUIPMENT SUPPORTS

- A. Structural steel for supports: ASTM A36.
 - 1. Use hot dipped galvanized members installed in fan plenums or areas of high humidity or condensation, in tunnels and outside. All fasteners shall be stainless steel. Any damage caused by cutting, drilling, or welding or any other means to galvanized surface must be repaired by applying two coats of cold-galvanizing.
 - 2. Furnish other members with shop coat of red primer.
 - 3. Retouch primer after field welding.

2.02 FLASHINGS AND COUNTERFLASHINGS

- A. Furnish materials and coordinate installation for flashing and counterflashing roof penetrations for vents, pipe, drains, and ducts.
- B. Materials:
 - 1. Sheetmetal: 24 gauge minimum ASTM A525, Class G90.
 - 2. Sheet lead: 3 pounds per square foot.
 - 3. Stainless steel: Minimum 20 gauge.

4. Sheet copper: 24 ounces per square foot.
5. Vent stack fitting: Josam 1830 or Jay R. Smith 1750. Contractor shall coordinate with architectural roofing details.

2.03 ESCUTCHEON PLATES

- A. Provide B & C No. 10 or equal chrome plated escutcheon plates where pipes penetrate partitions or ceilings in finished areas.

PART 3 EXECUTION

3.01 CUTTING AND PATCHING

- A. Where it becomes necessary to cut through any wall, floor or ceiling to permit the installation of any work of Division 23, or to repair any defects that may appear, the cutting shall be performed under the supervision of the General Contractor. Inform the Owner's representative before any work commences. No structural member shall be altered without the written permission of the Structural Engineer.
- B. Repair or replace damage caused by cutting or installation of work specified in Division 23.
- C. Perform repairs with materials which match existing and install in accordance with the appropriate section of these specifications.

3.02 FLASHING AND COUNTERFLASHING

- A. Counterflash ducts and pipes where penetration of roofs and outside walls occurs.

3.03 DELIVERY, STORAGE, AND PROTECTION

- A. Insofar as possible, deliver items in manufacturer's original unopened packaging. Where delivery in original packaging is not practical, provide cover and shielding for all items with protective materials to keep them from being damaged. Use care in loading, transporting, unloading, and storing to keep items from being damaged.
- B. Store items in a clean, dry place, and protect from damage. Mechanical equipment may not be staged or stored outdoors unless intended for outdoor use. If indoor storage is not available at the jobsite, the contractor shall provide warehouse storage until equipment can be stored within the building. Pre-fabricated ductwork and airside equipment shall be sealed at fabrication facility with sheet plastic to prevent contamination with dirt/debris. Protection to remain in place until assembly.
- C. Protect nameplates on motors, pumps, and similar equipment. Do not paint or insulate over nameplate data.
- D. Protect valves and piping from damage. Cover equipment during work of finishing trades.
- E. Keep dirt and debris out of pipes, ductwork, and airside equipment.
- F. Repair, restore, and replace damaged items.
- G. Cover factory finished equipment during work of finishing trades, such as fan coil units, fin tubes, etc.
- H. Cooling and/or heating coils shall be sealed and capped off by the manufacturer until installation. Coils shall be protected by temporary filter media and support structures during construction that are equal in efficiencies and methods to the final permanent filtration. Unit containing coils shall be inspected for contamination and signed off by Owner's representative prior to being turned over to Owner.
- I. Ductwork delivered to jobsite shall be sealed with shrinkwrap or taped sheet plastic and shall remain sealed until installation. Open ends of installed duct systems shall be sealed and protected during all stages of construction.

3.04 SLEEVES

- A. Floors: Sleeve all pipe penetrations. Extend sleeve 1-1/2" above finished floor, except piping within pipe chases. Sleeve shall be flush with underside of floor.
- B. Masonry or concrete walls: Sleeve all pipe penetrations. Sleeves shall be flush on both sides of wall.
- C. Drywall partitions: Sleeve all penetrations of piping in systems over 160 degrees F.
- D. Seal voids between outside surface of sleeve and wall, partition or floor. Seals shall be airtight.
- E. Install piping, insulation and sleeves in strict accordance with applicable U.L. floor or partition assembly instructions. Coordinate with Division 07 firestop manufacturer's installation instructions.
- F. Provide sleeves and seal all penetrations at existing piping through new partitions.
- G. Penetrations not sleeved or firestopped:
 - 1. Seal voids between pipe and partition. Seals shall be airtight.

3.05 ESCUTCHEON PLATES

- A. Provide chromium plated escutcheon plates for exposed uninsulated pipes projecting through floors or walls in "finished" spaces. Mechanical rooms, store rooms, electric closets, and janitor closets are not considered "finished" spaces.
- B. Clearance between sleeve and pipe: Minimum of 1/2 inch for hot piping and 1 inch for cold piping or as otherwise dictated by U.L. Fire Resistance Directory.

3.06 CLEANING HVAC SYSTEMS

- A. General cleanup:
 - 1. Upon completion of contract and progressively as work proceeds, clean up dirt, debris, oil materials, etc., and remove from site, keeping premises in neat and clean condition to satisfaction of the construction manager. See Division 01 specifications for additional requirements.
 - 2. Seepage, discoloration or other damage to parts of the building, its finish, or furnishings due to Contractor's failure to properly clean piping systems or duct systems shall be repaired without cost to the Owner.
- B. Factory finishes:
 - 1. Clean items with factory finishes. Touch up bare places, scratches and other minor damage to finishes. Use only factory supplied paint of matching color and formula. If finishes are badly damaged or if there are many damaged, scratched or bare places, refinish the entire item.
- C. Ducts and Apparatus:
 - 1. Thoroughly clean ducts and apparatus casings before fans and filters are operated.
 - 2. Keep ductwork sealed after cleaning and installation, prior to start-up. All duct openings shall be sealed at the end of the work session.

3.07 OPERATION OF HVAC SYSTEMS DURING CONSTRUCTION

- A. Install specified filters prior to system operation. In addition to specified filters, install a roughing filter upstream of mixed air filter. Roughing filter shall consist of two layers of roll filter media clipped and sealed to entering side of filter frame. Change roughing filter as necessary to minimize duct collection on specified filters.
- B. Cover return and exhaust air grilles with temporary filter media. Attach media to avoid damage to grille or ceiling. Change temporary media as required to protect against dust buildup on ductwork. Remove temporary media from grilles after flooring is installed, walls are sanded and painted and other dust generating construction has been completed.

- C. During periods of excessive dust generation such as drywall sanding, seal off return and exhaust openings and grilles to prevent dust from accumulating in ductwork.
- D. If outside air source contains less dust than building air, adjust A/C unit dampers to operate with as much outside air as possible without causing a freezing condition for coil or exceeding capacity of coil to adequately condition supply air.
- E. Furnish and install a new set of specified filter media prior to start of system test and balance. Furnish a new, clean set of the specified media and turn over to the Owner.
- F. Do not operate any air handling unit without all temporary construction filters, and scheduled filters, pre and final, installed.

3.08 TESTING MECHANICAL SYSTEMS

- A. Test all systems and equipment installed to demonstrate proper operation.
- B. Advise Engineer of Record of scheduled systems testing and completed system demonstration/operation schedules so that he may witness, if desired.
- C. Correct and retest work found defective when tested.
- D. Make repairs to piping systems with new materials. Peening, doping, or caulking of joints or holes will not be acceptable.
- E. Domestic Water Piping: Test hot and cold water piping systems upon completion of rough-in, before fixtures are connected, at a hydrostatic pressure of 125 psig pressure or at 1-1/2 times design working pressure, whichever is greater, for a period of two hours without evidence of leaking.
- F. Ductwork pressure testing: Refer to Section 23 3100 for required pressure testing of ductwork.
- G. System Balance and Testing: Prepare to assist test and balance firm by assuring systems are complete and operational.
- H. Records of Testing: Maintain records of system testing and results thereof. Deliver results as part of project closing file and on an intermediate basis as requested by the Architect and/or Engineer of Record.

3.09 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.10 SYSTEM STARTUP

- A. Provide manufacturer's field representative to perform systems startup.
- B. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.
- C. Adjust for proper operation within manufacturer's published tolerances.

3.11 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.
- C. Demonstrate proper operation of equipment to Owner's designated representative.
- D. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Conduct walking tour of project.
 - 3. Briefly describe function, operation, and maintenance of each component.

3.12 PROTECTION

- A. Do not permit traffic over unprotected floor surface.

END OF SECTION

SECTION 23 0513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single phase electric motors.
- B. Three phase electric motors.

1.02 RELATED REQUIREMENTS

- A. Division 26 - Electrical

1.03 REFERENCE STANDARDS

- A. Each motor, controller and all components shall be designed, manufactured and tested in accordance with the following latest applicable standards:
 - 1. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.; 1990 (Reapproved 2008).
 - 2. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; Institute of Electrical and Electronic Engineers; 2004.
 - 3. IEEE Standard 519-1992
 - 4. IEEE STD 444 (ANSI C34.3)
 - 5. National Electric Manufacturers Association Standards (NEMA)
 - 6. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.
 - 7. NEMA - ICS-3-303
 - 8. Energy Policy Act of 1992 (EP Act)
 - 9. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. All equipment and material to be furnished and installed on this project shall be UL or ETL listed, in accordance with the requirements of the authorities having jurisdiction, and suitable for its intended use on this project.

1.04 SUBMITTALS

- A. Submit motor information with submittals and shop drawings for Division 23 equipment.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

1.05 QUALITY ASSURANCE

- A. Conform to NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.07 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

- B. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Baldor: www.baldor.com/
- B. Century: www.centuryelectricmotor.com/
- C. General Electric: <http://www.gepowerconversion.com/>
- D. Lincoln Motors: www.lincolnmotors.com.
- E. Marathon: www.marathonelectric.com/
- F. Reliance Electric/Rockwell Automation: www.reliance.com.
- G. Toshiba: <https://www.toshiba.com/tic/industrial/motors>
- H. Westinghouse: <http://tecowestinghouse.com>

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service:
 - 1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
 - 2. Motors Larger than 1/2 Horsepower: 208 volts, three phase, 60 Hz.
- B. All motors shall be started across the line, unless specified otherwise. All motors 100 horsepower and larger shall be suitable for wye-delta starting unless specified otherwise. Motors shall be selected with low starting current and shall be designed for continuous duty to provide the running torque and pull in torque required to suit the load. Unless otherwise indicated on the Contract Documents, all motors shall be single speed (1750 rpm). All motors shall have standard open drip-proof enclosures unless otherwise specified. All motors installed outside and exposed to the weather shall be of the totally enclosed fan cooled (TEFC) or totally enclosed air over (TEAO) types. All motors not utilized with variable speed drives shall have a minimum service factor of 1.15 and shall be selected to operate at design conditions without exceeding their nameplate rating (without exploiting the service factor rating). Motors used in conjunction with variable speed drives shall have a 1.00 service factor unless otherwise indicated and be compatible with the drive and rated for inverter output duty. Two (2) speed motors shall be two (2) speed, two (2) winding or two (2) speed, single winding type as specified herein and as indicated on the Contract Documents.
- C. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Standard open drip proof three (3) phase motors ten (10) horsepower and smaller shall have cast aluminum end bells with steel frames. Three (3) phase motors fifteen (15) horsepower and larger shall have cast iron end bells and housings.
 - 3. Standard open drip proof single phase motors shall have cast aluminum end bells with steel frames.
 - 4. Design for continuous operation in 40 degrees C environment.
 - 5. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 6. Totally enclosed fan cooled (TEFC) and totally enclosed air over (TEAO) three (3) phase motors shall have cast iron housings. TEFC motors shall have corrosion resistant fans.
- D. Windings and Insulation:
 - 1. All motors shall have copper windings.
 - 2. Motors shall be equipped with Class B, 80°C rise or Class F, 105°C rise insulation suitable for use in a 40°C ambient temperature. All motors used for cooling tower applications shall be equipped with Class F, 105°C rise insulation suitable for use in a 40°C ambient temperature. Windings shall be treated with an epoxy varnish to inhibit the absorption of moisture.

- E. Bearings:
 - 1. Single phase, fractional horsepower motors shall be equipped with quiet operating, all angle, babbitt lined sleeve bearings.
 - 2. Polyphase motors shall be equipped with deep groove type ball bearings, generously sized for the loads to which applied and for severe duty application. Provide the necessary seals on the shaft to keep the bearing system free of contamination and moisture. Lubricant shall be high temperature, nonbleeding grease.
 - a. Provide inlet and outlet plugs on poly-phase motors so that grease fittings can be easily inserted for bearing relubrication except as otherwise specified. The end shields shall be carefully machined to add extra grease capacity. Lower outlet plugs shall be equipped with combination breather/drains on TEFC and TEAO motors.
- F. Motors shall be specifically designed for quiet operation and for severe duty. Standard open drip proof motors shall be equipped with aluminum or stainless steel stamped nameplates. Totally enclosed fan cooled and air over motors shall be equipped with stainless steel stamped nameplates with either zinc or cadmium plated hardware. Visible motor nameplates shall clearly indicate frame size, horsepower, frequency, voltage, phase, cycles, RPM/speed, full load amps, locked rotor amps, starting torque class, insulation class, manufacturer's name and model number, service factor, power factor, efficiency and winding material.
- G. Motors on belt driven equipment shall have slide rails with adjusting screws for belt tension adjustment. Motors exposed to the weather shall be weather protected.
- H. Motors specified with variable frequency drive controllers shall be inverter duty rated and shall be insulated against eddy currents.
- I. Wiring Terminations:
 - 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 - 2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.
- J. Sound power levels not greater than recommended in NEMA M61-12.49. VFD duty rated motors shall not increase by more than 3 dB when operating on VFD.
- K. Provide motors with drive shafts long enough to extend completely through belt sheaves when sheaves are properly aligned or balanced.

2.03 APPLICATIONS

- A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not conform to these specifications.
- B. Single phase motors for shaft mounted fans and oil burners: Split phase type.
- C. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.
- D. Single phase motors for fans, pumps, blowers, and air compressors: Capacitor start type.
- E. Single phase motors for fans and blowers: Capacitor start, capacitor run type.
- F. Motors located in exterior locations, air cooled condensers, and direct drive axial fans: Totally enclosed type.
- G. Motors located outdoors: Totally enclosed weatherproof epoxy-sealed type.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

- D. Arrange and set motors.
- E. Line up motors on direct drive equipment using dial type gauges.
- F. Make connections and test motor for proper rotation/phasing under Division 26.
- G. Install premium efficiency electric motors for motors 1 horsepower and above. Premium efficiency motors shall have efficiency and losses determined in accordance with the latest revisions of IEEE Standard 112. Polyphase squirrel-cage motors rated 1 through 125 horsepower shall be tested by dynamometer method B. The efficiency will be determined using segregated losses in which stray load loss is obtained from a linear regression analysis to reduce the effect of random errors in the test measurements. Guaranteed minimum load efficiency shall be per schedule below.

3.02 SCHEDULE

- A. Three Phase - Energy Efficient, Open Drip-Proof Performance:
 - 1. 1200 rpm, 1800 rpm, and 3600 rpm.
 - a. 3/4 hp
 - 1) Minimum Percent Efficiency: 80.0.
 - b. 1 hp:
 - 1) Minimum Percent Efficiency: 85.5.
 - c. 1-1/2 hp:
 - 1) Minimum Percent Efficiency: 86.5.
 - d. 2 hp:
 - 1) Minimum Percent Efficiency: 86.5.
 - e. 3 hp:
 - 1) Minimum Percent Efficiency: 89.5.
 - f. 5 hp:
 - 1) Minimum Percent Efficiency: 89.5.
- B. Three Phase - Energy Efficient, Totally Enclosed, Fan Cooled Performance:
 - 1. 1200 rpm, 1800 rpm, and 3600 rpm.
 - a. 3/4 hp:
 - 1) Minimum Percent Efficiency: 80.0.
 - b. 1 hp:
 - 1) Minimum Percent Efficiency: 85.5.
 - c. 1-1/2 hp:
 - 1) Minimum Percent Efficiency: 86.5.
 - d. 2 hp:
 - 1) Minimum Percent Efficiency: 86.5.
 - e. 3 hp:
 - 1) Minimum Percent Efficiency: 89.5.
 - f. 5 hp:
 - 1) Minimum Percent Efficiency: 89.5.

3.03 ADJUSTMENTS

- A. Motors, together with driven equipment, shall be dynamically and statically balanced. Imbalance shall be reduced to minimum specified by equipment manufacturers.

END OF SECTION

SECTION 23 0548

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Equipment support bases.
- B. Vibration isolators.
- C. Roof curbs.

1.02 WORK INCLUDED

- A. Provide vibration isolators, pipe supports, and equipment anchors, of appropriate sizes and weight loading to meet the specified deflection requirements, in accordance with instructions of isolator manufacturer in order to dampen the noise and vibration transmission of mechanical equipment.
- B. Mechanical equipment shall be mounted on or suspended with the vibration isolators to prevent transmission of vibration to Building structure.
- C. Coordinate installation with other trades (placement of anchor bolts in concrete slabs, etc.).
- D. Flexible ductwork connections are specified in Section 23 3300.

1.03 MANUFACTURER RESPONSIBILITIES

- A. Manufacturer of vibration isolation shall have the following responsibilities:
 - 1. Determine vibration isolation sizes and locations for mechanical and plumbing equipment.
 - 2. Provide isolation systems for all plumbing and mechanical of equipment (vibration isolated and non-isolated) and systems (piping and ductwork).
 - 3. Provide installation instructions and drawings.
 - 4. Certification must be substantiated by calculations or test reports verified by a licensed engineer.
 - 5. Vibration isolation specialist shall coordinate his work with that of other trades to verify that equipment speeds, in revolution per minute (rpm), are based upon actual equipment installed at the project site.
 - 6. Verify that equipment rpm and spring deflection selected are arranged so that resonance is avoided.
- B. Exact mounting sizes, dimensions and quantity of isolators and static deflection required shall be determined by the isolator manufacturer based upon equipment that will be furnished and installed by the contractor under this Contract.

1.04 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads for Buildings and Other Structures; 2011.
- B. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2011.
- C. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel; International Accreditation Service, Inc.; 2011.

1.05 SUBMITTALS

- A. Contractor's Certification: Vibration isolator submittals shall include a certification, signed by an officer representing the Contractor and stipulating that the submittal prepared by the manufacturer has been reviewed, and checked on an item by item basis against each piece of mechanical equipment, piping, ductwork and panel shown or specified in the Contract Documents, which requires vibration isolation and/or seismic support.
- B. Manufacturer's Certification: The manufacturer or manufacturers (if there are more than one) shall each certify that the selections of vibration isolation equipment are based upon the

drawings and specifications, and that each piece of mechanical equipment has been examined for rotational speed, equipment type, mounting location, and supporting span between column centers, and that an appropriate isolator has been selected.

- C. Product Data:
 - 1. Provide manufacturer's product literature documenting compliance with PART 2 PRODUCTS.
 - 2. Furnish manufacturer's product data covering each isolator type for style, characteristic, and finish. Isolator quantities, dimensions, deflections, capacities and types shall remain the responsibility of the manufacturer and the contractor.
- D. Shop Drawings:
 - 1. Provide schedule of vibration isolator type with location and load on each.
 - 2. Fully dimensioned fabrication drawings and installation details for vibration isolation bases, member sizes, attachments to isolators, and supported equipment.
 - 3. Provide layout drawings, drawn to a scale of not less than 1/8-inch to 1-foot, showing the proposed layout of equipment and piping systems and the location and type of each vibration isolation and seismic restraint device. Carefully examine other sections requiring coordinated shop drawings, including but not limited to Section 23 31 13, "Sheetmetal Ductwork", Section 23 31 14, "Sheetmetal - Special Ductwork", and prepare restraint/isolation shop drawings to the same scale showing the location of each vibration isolation equipment base, pipe hanger, flexible connection, and isolator/seismic restraint device.
 - 4. Include auxiliary motor slide bases and rails, base weights, inertia bases, concrete weights, equipment static loads, support points, vibration isolators, and detailed layout of isolator location and orientation with static and dynamic load on each isolator.
 - 5. Include selections from prescriptive design tables that indicate compliance with the applicable building code and the vibration isolator manufacturer's requirements.
 - 6. Clearly indicate the load and capacity assumptions selected. Include copies of any calculations.
- E. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

1.06 STORAGE AND PROTECTION

- A. Storage: Store vibration isolation equipment indoors in the manufacturer's original shipping containers. Preclude the entrance of construction dirt and debris. Vibration isolation equipment and bases, which show signs of rust, cement or concrete fouling, dirt and construction debris shall be disassembled and cleaned, approved or removed from the project site and replaced with new.

1.07 QUALITY ASSURANCE

- A. Perform design and installation in accordance with applicable codes.
- B. Responsibility for Products: Select deflection for spring isolators in accordance with recommendations in the current issue of ASHRAE Handbook of Fundamentals, unless noted otherwise on drawings.
- C. Designer Qualifications: Perform design under direct supervision of a Professional Engineer experienced in design of this type of work and registered and licensed in Florida.
- D. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
 - 1. Member of Vibration Isolation and Seismic Control Manufacturers Association (VISCMA).
- E. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years of experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Kinetics Noise Control, Inc: www.kineticsnoise.com.
- B. Mason Industries: www.mason-ind.com.
- C. Thybar Corporation: www.thybar.com.
- D. Vibration Eliminator Company, Inc: www.veco-ny.com.
- E. Furnish vibration isolators by single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. General:
 - 1. All vibration isolators, base frames and inertia bases to conform to all uniform deflection and stability requirements under all operating loads.
 - 2. Materials and equipment shall conform to the respective specifications and other requirements specified below:
 - a. Squarehead bolts and heavy hexagon nuts, ANSI B18.2.1 and ANSI B18.2.2, and ASTM A 307 or ASTM A 576.
 - 3. Steel springs to function without undue stress or overloading.
 - 4. Steel springs to operate in the linear portion of the load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
 - 5. Lateral to vertical stiffness ratio to not exceed 0.08 with spring deflection at minimum 75 percent of specified deflection.
 - 6. All equipment mounted on vibration isolated bases to have minimum operating clearance of 2 inches between the base and floor or support beneath unless noted otherwise.
 - 7. Vibration isolators, hardware and baseplates shall be hot dipped galvanized where exposed to the weather.

2.03 EQUIPMENT SUPPORT BASES

- A. Structural Bases:
 - 1. Construction: Engineered, structural steel frames with welded brackets for side mounting of the isolators.
 - 2. Frames: Square, rectangular or T-shaped.
 - 3. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.

2.04 VIBRATION ISOLATORS

- A. Non-Seismic Type:
 - 1. Type 1: Mason Super "W", 2 layers of 3/4" neoprene pad with 16 ga. galvanized shim.
 - 2. Type 2: Mason BR, two neoprene elements housed in a ductile iron casting.
 - 3. Type 3: Mason SLF, free standing spring isolator, 1/4" neoprene non-skid pad, leveling bolt, spring diameter no less than 0.8 of compressed height at rated load, minimal additional travel to solid equal to 50% or rated deflection.
 - 4. Type 4: Mason SLR, restrained spring isolator, vertical limit stops, internal isolation pad.
 - 5. Type 5: Mason SSLH, housed spring isolator, vertical limit stops, designed to provide all directional snubbing.
 - 6. Type 6: Mason 30N, spring and double neoprene hanger, 1-1/4" neoprene element at top of housing, spring seated in neoprene cup at bottom of housing, designed to allow 30 degrees arc from side to side of hanger rod.
 - 7. Type 6A: Mason PC30N, spring and double neoprene hanger, 1-1/4" neoprene element at top of housing, spring seated in neoprene cup at bottom of housing, designed to allow 30 degree arc from side to side of hangar rod, precompressed and locked at rated deflection with seismic up stop, with scale to show deflection.

8. Type 7: Mason SCB, SCBH, SCBV cable assembly, galvanized aircraft cable with steel cable end connections, designed to resist seismic loads with a minimum safety factor of 2.
9. Type 8: Mason SSB, solid steel channel brace with steel connector assemblies, designed to resist seismic loads with a minimum safety factor of 2.
10. Type 9: Mason Z-1225 all-directional snubber, interlocked steel members restrained by replaceable neoprene bushing.
11. Type 10: Mason BMK rectangular steel frame form for concrete inertia base, 1/2" reinforcing bars on 6" centers, in each direction.
12. Type 11: Mason RSC, spring isolation curb for roof mounted equipment, heavy gauge Z section sheet metal base that supports adjustable and removable restrained spring mounts, top section to be continuous rail support for equipment; springs to rest on 1/4" neoprene pads; hardware shall be plated and springs furnished with rust resistant finish; curb to be waterproofed using continuous galvanized flexible counter flashing, joined at corners with EDAM bellows; spring locations to have removable, waterproof access ports.

2.05 ROOF CURBS

- A. Vibration Isolation Curbs:
 1. Non-Seismic Curb Rail:
 - a. Location: Between existing roof curb and rooftop equipment.
 - b. Construction: Steel.
 - c. Integral vibration isolation to conform to requirements of this section.
 - d. Weather exposed components consist of corrosion resistant materials.
 2. Non-Seismic Curb:
 - a. Location: Between structure and rooftop equipment.
 - b. Construction: Steel.
 - c. Integral vibration isolation to conform to requirements of this section.
 - d. Weather exposed components consist of corrosion resistant materials.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Install in accordance with isolator manufacturer's instructions and equipment manufacturer's instructions.
- B. Size vibration control equipment in accordance with weight distribution, pull or the imposed torque as shown on equipment shop drawings. Minimum static deflections may be revised subject to prior approval.
- C. Provide revised vibration control equipment to match revised or substituted equipment.
- D. Install equipment on vibration isolation curbs to provide watertight seal.
- E. Bases:
 1. Adjust equipment level.
- F. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
- G. Set anchor bolts when concrete is placed.
- H. Isolate mechanical equipment as indicated.
- I. Remove all debris from under equipment, and thoroughly clean steel bases, inertia bases and check for free movement.
- J. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

3.02 APPLICATIONS

- A. Equipment: Use the restraint types listed above on the following applications:

Lokey Nissan
EQUIPMENT

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND

1. A/C units, indoor, not internally isolated: type 3.
2. A/C units, packaged rooftop: type 11

3.03 ANCHORING

- A. Installation: Installation shall comply with manufacturer's published recommendations and shall be installed so that isolators are plumb and are operating at a manner for which they were designed.
- B. Unless otherwise specified, all equipment shall be securely bolted to isolators, steel bases or concrete inertia bases.

3.04 ANCHOR BOLTS

- A. If the size and number of the anchor bolts are not shown on the drawings then anchor bolts shall conform to the schedule for the various equipment weights or the manufacturer's installation recommendations, whichever is the most stringent.

3.05 FIELD QUALITY CONTROL

- A. Inspect isolated equipment after installation and submit report. Include static deflections.

END OF SECTION

SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.

1.02 RELATED REQUIREMENTS

- A. Section 23 0500 - Common Work Results for HVAC.

1.03 REFERENCE STANDARDS

- A. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2013.

1.04 SUBMITTALS

- A. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.
- D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.
- B. Control Panels: Nameplates.
- C. Dampers: Ceiling tacks, where located above lay-in ceiling.
- D. Ductwork: Nameplates.
- E. Duct smoke detectors: Ceiling tacks, where located above lay-in ceiling.
- F. Fans: Nameplates.
- G. Relays: Tags.
- H. Small-sized Equipment: Tags.
- I. Thermostats: Nameplates.

2.02 NAMEPLATES

- A. Manufacturers:
 - 1. Advanced Graphic Engraving: www.advancedgraphicengraving.com.
 - 2. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com.
 - 3. Seton Identification Products: www.seton.com.
- B. Letter Color: White.
- C. Letter Height: 1/2 inch minimum.
- D. Fill engraved lettering with a permanent coloring material which contrasts with color of tag material to allow for easy reading.
- E. Use names, numbers and abbreviations appearing in schedules on Contract Drawings.
- F. Plastic: Conform to ASTM D709.

2.03 TAGS

- A. Manufacturers:
 - 1. Advanced Graphic Engraving: www.advancedgraphicengraving.com.
 - 2. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com.
 - 3. Seton Identification Products: www.seton.com.

- B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- D. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 CEILING TACKS

- A. Manufacturers:
 - 1. Craftmark: www.craftmarkid.com.
- B. Description: Steel with 3/4 inch diameter color coded head.
- C. Color code as follows:
 - 1. HVAC Equipment: Yellow.
 - 2. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Locate ceiling tacks to locate duct smoke detectors above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 23 0593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Measurement of final operating condition of HVAC systems.

1.02 RELATED REQUIREMENTS

- A. Section 23 0500 - Common Work Results for HVAC.

1.03 REFERENCE STANDARDS

- A. AABC MN-1 - AABC National Standards for Total System Balance; Associated Air Balance Council; 2002.
- B. ASHRAE Std 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2008.
- C. NEBB (TAB) - Procedural Standards for Testing Adjusting Balancing of Environmental Systems; National Environmental Balancing Bureau; 2005, Seventh Edition.
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting, and Balancing; Sheet Metal and Air Conditioning Contractors' National Association; 2002.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Submit to Engineer.
 - 2. Include at least the following in the plan:
 - a. Preface: An explanation of the intended use of the control system.
 - b. List of all air flow, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - c. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - d. Identification and types of measurement instruments to be used and their most recent calibration date.
 - e. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - f. Final test report forms to be used.
 - g. Detailed step-by-step procedures for TAB work for each system and issue, including:
 - 1) Terminal flow calibration (for each terminal type).
 - 2) Diffuser proportioning.
 - 3) Branch/submain proportioning.
 - 4) Total flow calculations.
 - 5) Rechecking.
 - 6) Diversity issues.
 - h. Expected problems and solutions, etc.
 - i. Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
 - j. Details of how TOTAL flow will be determined; for example:

- 1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - k. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
 - l. Confirmation of understanding of the outside air ventilation criteria under all conditions.
 - m. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
 - n. Method of checking building static and exhaust fan and/or relief damper capacity.
 - o. Proposed selection points for sound measurements and sound measurement methods.
 - p. Methods for making coil or other system plant capacity measurements, if specified.
 - q. Time schedule for TAB work to be done in phases (by floor, etc.).
 - r. Description of TAB work for areas to be built out later, if any.
 - s. Time schedule for deferred or seasonal TAB work, if specified.
 - t. False loading of systems to complete TAB work, if specified.
 - u. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
 - v. Interstitial cavity differential pressure measurements and calculations, if specified.
 - w. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
 - x. Procedures for formal progress reports, including scope and frequency.
 - y. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- E. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
1. Submit to the Construction Manager within two weeks after completion of testing, adjusting, and balancing.
 2. Revise TAB plan to reflect actual procedures and submit as part of final report.
 3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Engineer and for inclusion in operating and maintenance manuals.
 4. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
 5. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 6. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 7. Units of Measure: Report data in I-P (inch-pound) units only.
 8. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Project Engineer.
 - g. Project Contractor.

h. Report date.

- F. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
1. AABC MN-1, AABC National Standards for Total System Balance.
 2. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
 3. Maintain at least one copy of the standard to be used at project site at all times.
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. If these specifications set forth more stringent requirements than the AABC National Standards, these specifications shall prevail.
- E. TAB Agency Qualifications:
1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 2. The firm shall have completed six projects of like size and scope.
 3. The firm shall maintain current insurance coverages in the minimum amounts specified in other sections of these specifications. The insurance coverage shall be carried with companies satisfactory to the Owner. Certificates of each of the above policies, together with a statement by the issuing company to the effect that said policy will not be cancelled without ten (10) days prior notice being given the Owner, shall be delivered to the Owner before any work is started.
 4. The firm shall be capable of performing the services specified at the location of the facility described within the time specified, of preparing and submitting the detailed report of the actual field work performed, and following up the basic work as may be required.
 5. Having minimum of three years documented experience.
 6. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabchq.com; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org.
- F. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.
- G. Pre-Qualified TAB Agencies:
1. Bay to Bay Balancing, Inc..
 2. Professional Air Balancing, Inc..
 3. Southern Independent Testing Agency, Inc..

3.02 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
1. Temperature control systems are installed complete and operable.
 2. Filters are clean and in place. If required, install temporary media in addition to filters.
 3. Duct systems are clean of debris.
 4. Fans are rotating correctly.
 5. Air coil fins are cleaned and combed.
 6. Access doors are closed and duct end caps are in place.

7. Air outlets are installed and connected.
 8. Duct system leakage is minimized.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
 - C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
 1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Engineer to facilitate spot checks during testing.
- C. Provide additional balancing devices as required.

3.04 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
 1. Running log of events and issues.
 2. Discrepancies, deficient or uncompleted work by others.
 3. Contract interpretation requests.
 4. Lists of completed tests.
- B. On completion of work, submit three copies of the complete report to include the following:
 1. Dates, time, personnel, status of operating of cooling or heating.
 2. A description of the procedure used for air and water balance.
- C. Ensure recorded data represents actual measured or observed conditions.
- D. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- E. Mark on the drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- F. Make changes to pulleys, belts, dampers, impellers, and similar equipment to obtain design conditions as required by TAB procedures.
- G. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- H. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- I. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- J. Check and adjust systems approximately six months after final acceptance and submit report.

3.06 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities .
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.

- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

3.07 SCOPE

- A. Test, adjust, and balance the following:
 - 1. Packaged Roof Top Heating/Cooling Units
 - 2. Air Handling Units
 - 3. Fans
 - 4. Air Filters
 - 5. Air Inlets and Outlets

3.08 MINIMUM DATA TO BE REPORTED

- A. Cooling Coils:
 - 1. Identification/number
 - 2. Location
 - 3. Service
 - 4. Manufacturer
 - 5. Air flow, design and actual
 - 6. Entering air DB temperature, design and actual
 - 7. Entering air WB temperature, design and actual
 - 8. Leaving air DB temperature, design and actual
 - 9. Leaving air WB temperature, design and actual
- B. Electric Heaters:
 - 1. Manufacturer
 - 2. Identification/number
 - 3. Location
 - 4. Model number
 - 5. Design kW
 - 6. Number of stages
 - 7. Phase, voltage, amperage
 - 8. Test voltage (each phase)
 - 9. Test amperage (each phase)
 - 10. Air flow, specified and actual
 - 11. Temperature rise, specified and actual
- C. Return Air/Outside Air:
 - 1. Identification/location
 - 2. Actual air flow
 - 3. Actual return air flow
 - 4. Actual outside air flow
 - 5. Return air temperature
 - 6. Outside air temperature

7. Actual mixed air temperature
8. Actual outside/return air ratio
- D. Exhaust Fans:
 1. Location
 2. Manufacturer
 3. Model number
 4. Serial number
 5. Air flow, specified and actual
 6. Total static pressure (total external), specified and actual
 7. Inlet pressure
 8. Discharge pressure
 9. Fan RPM
- E. Duct Traverses:
 1. System zone/branch
 2. Duct size
 3. Area
 4. Test velocity
 5. Test air flow
 6. Duct static pressure
 7. Air temperature
 8. Air correction factor
- F. Duct Leak Tests:
 1. Description of ductwork under test
 2. Duct design operating pressure
 3. Duct design test static pressure
 4. Duct capacity, air flow
 5. Maximum allowable leakage duct capacity times leak factor
 6. Test apparatus
 - a. Blower
 - b. Orifice, tube size
 - c. Orifice size
 - d. Calibrated
 7. Test static pressure
 8. Test orifice differential pressure
 9. Leakage
- G. Air Distribution Tests:
 1. Air terminal number
 2. Room number/location
 3. Terminal type
 4. Terminal size
 5. Area factor
 6. Design velocity
 7. Design air flow
 8. Test (final) velocity
 9. Test (final) air flow
 10. Percent of design air flow

END OF SECTION

SECTION 23 0713
DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Duct insulation.

1.02 RELATED REQUIREMENTS

- A. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 23 0553 - Identification for HVAC Piping and Equipment.
- C. Section 23 3100 - HVAC Ducts and Casings: Glass fiber ducts.

1.03 REFERENCE STANDARDS

- A. ASTM C553 - Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013.
- B. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts; 2011.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.
- D. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.
- E. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2013.
- F. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- G. SMACNA (DCS) - HVAC Duct Construction Standards; Sheet Metal and Air Conditioning Contractors' National Association; 2005.
- H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.02 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. Knauf Insulation: www.knaufusa.com.
 - 2. Johns Manville Corporation: www.jm.com.
 - 3. Owens Corning Corporation: www.ocbuildingspec.com.
 - 4. CertainTeed Corporation: www.certainteed.com.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Apply jacketed blanket type glass fiber covering to ducts pulled snug but not so tight as to compress corners more than 1/4". Use insulation having 2" tab, or cut insulation long enough to allow for "peel-off" of insulation from jacket to effect a minimum overlap of 2". Staple lap with flare type staples on 1" centers. Cover standing seams, stiffeners, and braces with same insulation blanket, using 2" jacket lap and staple lap as herein before outlined. Cover and seal all staples with Foster 30-80 reinforced with glass cloth. Do not use pressure sensitive tape.
 - 4. Secure jacket to covering using equivalent of Foster No. 85-20 Spark-Fas or Childers CP-82 Chil-Stix FRN adhesive.

2.03 MATERIALS FOR SPECIAL COVERINGS

- A. For externally insulated sheet metal ducts when above grade exposed-to-the-weather outside building slope ductwork and insulation to allow drainage and prevent ponding of water on top of ductwork. Cover duct insulation with glass mesh embedded and adhered to insulation using air drying weatherproof plastic fabricated cutback asphalt adhesive and finish with two coats of gray color flexible fire retardant protective coating having proven ability to withstand wide temperature range without cracking or crazing and be highly resistant to damage by bumping and abrading, equivalent to Johns Manville Insulkote.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that ducts have been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Insulated ducts conveying air below ambient temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 3. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- C. Insulated ducts conveying air above ambient temperature:
 - 1. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. External Duct Insulation Application:

1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
2. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
3. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
4. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

END OF SECTION

SECTION 23 2300
REFRIGERANT PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.

1.02 REFERENCE STANDARDS

- A. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2013 (ANSI/ASHRAE Std 15).
- B. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2013.
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2013.
- D. ASME B16.26 - Cast Copper Alloy Fittings For Flared Copper Tubes; The American Society of Mechanical Engineers; 2013.
- E. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; The American Society of Mechanical Engineers; 2013.
- F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2013.
- G. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2009.
- H. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.
- I. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2013.
- J. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2011 and errata.
- K. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.

1.03 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum five years of documented experience.

PART 2 PRODUCTS

2.01 PIPING

- A. Copper Tube: ASTM B280, H58 hard drawn or O60 soft annealed.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy.
- B. Copper Tube to 7/8 inch OD: ASTM B88 (ASTM B88M), Type K (A), annealed.

1. Fittings: ASME B16.26 cast copper.
2. Joints: Flared.
- C. Pipe Supports and Anchors:
 1. Provide hangers and supports that comply with MSS SP-58.
 - a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron adjustable swivel, split ring.
 3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 4. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 5. Vertical Support: Steel riser clamp.
 6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 7. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 8. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
 9. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
 - a. Bases: High density, UV tolerant, polypropylene or reinforced PVC.
 - b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
 - e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.

2.02 REFRIGERANT

- A. Refrigerant: R410a as defined in ASHRAE Std 34.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- E. Inserts:
 1. Provide inserts for placement in concrete formwork.
 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- F. Pipe Hangers and Supports:
 1. Install in accordance with ASME B31.5.
 2. Support horizontal piping as scheduled.

3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 4. Place hangers within 12 inches of each horizontal elbow.
 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 6. Provide copper plated hangers and supports for copper piping.
- G. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
- H. Flood piping system with nitrogen when brazing.
- I. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
- J. Fully charge completed system with refrigerant after testing.

3.03 FIELD QUALITY CONTROL

- A. Test refrigeration system in accordance with ASME B31.5.

3.04 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.

END OF SECTION

SECTION 23 3100
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal ductwork.
- B. Duct cleaning.

1.02 RELATED REQUIREMENTS

- A. Section 23 0500 - Common Work Results for HVAC.
- B. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.
- C. Section 23 0713 - Duct Insulation: External insulation and duct liner.
- D. Section 23 3300 - Air Duct Accessories.
- E. Section 23 3700 - Air Outlets and Inlets.
- F. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.

1.03 REFERENCE STANDARDS

- A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals; 2013.
- B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2012.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2013.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.
- E. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2012.
- F. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2013.
- G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.
- H. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems; National Fire Protection Association; 2012.
- I. SMACNA 1972 - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2012, 2nd Edition.
- J. SMACNA (DCS) - HVAC Duct Construction Standards, Metal and Flexible, Third Edition; 2005.
- K. SMACNA (FGD) - Fibrous Glass Duct Construction Standards; Sheet Metal and Air Conditioning Contractors' National Association; 2003.
- L. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.04 SUBMITTALS AND SHOP DRAWINGS

- A. Submit material/product data as described in Division 01.
- B. Product Data: Provide data for duct materials.
- C. Coordinated Shop Drawings: Provide coordinated shop drawings for sheet metal work in mechanical equipment rooms, and other congested areas listed.
 - 1. Draw to a scale of 1/2 inch to one foot
 - 2. Provide sheet sizes to match Contract Drawings
 - 3. Show duct sizes
 - 4. Show bottom duct elevations from finished floor
 - 5. Show lighting, equipment, piping, columns and beams, with mounting heights

6. Show construction details of all fittings
7. Show construction details of plenums and casing
- D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual, Second Edition; 2012.
- E. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum five years of documented experience.

1.06 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A standards.

1.07 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.01 DUCT ASSEMBLIES

- A. Regulatory Requirements: Construct ductwork to NFPA 90A standards.
- B. All Ducts: Rigid glass fiber to match existing, unless otherwise indicated.

2.02 PRESSURE CLASSIFICATIONS

- A. Ductwork where maximum dimension is less than 97" shall be constructed based on applicable pressure classification in accordance with SMACNA Manual including sheetmetal gauge, reinforcement gauge and spacing.
- B. Construct the following for 1" pressure classification, Table 1- 4.
 1. Supply and return ductwork.
- C. General Exhaust: 1/2 inch w.g. pressure class, galvanized steel.

2.03 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized prime quality steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
- B. Screws: Cadmium plated.
- C. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 2. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E84.
 3. For Use With Flexible Ducts: UL labeled.
 4. Products:
 - a. Carlisle HVAC Products; Hardcast RTA-50, consisting of two parts, mineral-gypsum-compound-impregnated woven fiber tape and plastic type activator/adhesive: www.carlislehvac.com

- D. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
- E. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 - 1. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 - 2. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
 - 3. Other Types: As required.
 - 4. Manufacturers:
 - a. Powers Fasteners, Inc: www.powers.com.

2.04 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
- B. Ducts shall be neatly finished on the outside with all sharp edges removed.
- C. Inside surfaces shall be smooth with no projections into the airstream, except where otherwise indicated.
- D. No variation of duct configuration or size permitted except by written permission. Size round duct installed in place of rectangular ducts in accordance with ASHRAE Handbook - Fundamentals.
- E. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- F. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes as specified in Section 23 3300.
- G. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- H. Changes in shape and dimension shall conform to SMACNA Figure 2-9.
- I. Dissimilar metals shall be connected with flanged joints made up with neoprene gaskets to prevent contact between metals. Flanges shall be fastened with bolts protected by ferrules and washers made of the same materials as the gaskets.
- J. All fasteners and attachments shall be made of the same materials as the ducts or of corrosion-resistant material.

2.05 RECTANGULAR DUCTWORK

- A. Transverse Joints:
 - 1. "S" and drive construction for 1" and 2" pressure classification.
 - a. Provide duct gauge and reinforcing angles in accordance with Table 1-11
 - 2. Duct Connection System: Connection system as manufactured by Ductmate or Nexus shall incorporate gasketed joints, metal cleats and bolted corners. Minimum metal gauge shall be 24 gauge. Connection systems may be used for all pressure classifications.
 - 3. For pressure classifications above 2", use double "S" joint up to 30" and companion angle or manufacturer's connection system above 30".
- B. Longitudinal joints in rectangular ducts shall be Pittsburgh lock seams hammered tight and shall be located above the horizontal axis of the duct. A snap lock seam shall not be permitted as a substitute for the Pittsburgh lock seam.
- C. Transitions:
 - 1. Do not exceed 1" in 7" of slope for increase-in-area transitions.
 - 2. Do not exceed 1" in 4" of slope for decrease-in-area transitions, 1" in 7" is preferable.
 - 3. Do not exceed 45 degrees on the entering or leaving side for angle of transitions at connections to equipment without the use of approved vanes.
- D. Elbows:

1. Fabricate ells using one of the following specifications: The fabrication methods are listed in order of preference. Use radius elbows where ever possible. Use square elbows only when available space prevents the use of radius elbows.
 - a. Unvaned, long radius elbow with the throat radius equal to 3/4 of the width of the duct and with a full heel radius.
 - b. Six inch throat radius with full radius, single thickness vanes and full heel radius. Maximum unsupported length of vanes shall be 36". Securely fasten vanes to runners. Secure vanes in stable position. Construct vane edges to project tangents parallel to duct sides.
 - c. Square elbows with airfoil, double thickness turning vanes.
- E. Branch Connections:
 1. Pressure classification 2" and less:
 - a. Rectangular branch from rectangular main: 45 degree entry with all corners closed as shown in Figure 2-8
 - b. Round branches: Spin-in fitting without scoop.
 - c. Parallel flow branches: See Figure 2-7.
 - d. Space duct joints to avoid cutting them for branch take offs and outlet collars.
- F. Duct Sealing:
 1. All longitudinal and transverse joints, seams and duct sidewall penetrations, regardless of pressure classification, shall be sealed with duct sealer. Follow SMANCA Table 1-2, Seal Class A for all supply, return and exhaust ductwork.

2.06 ROUND DUCTWORK

- A. Applicable for pressure classification above 2".
- B. Round Duct (Spiral Pipe) and Fittings:
 1. Manufactured from galvanized steel meeting ASTM A-525. Construction shall be in accordance with SMACNA HVAC Duct Construction Standards and manufacturer's standards.
 2. Use appropriate seams made to eliminate leakage based on pressures for which system has been designed. Longitudinal seam duct to have fusion welded butt seam.
 3. Fittings and couplings shall have minimum gauges specified by SMACNA Manual.
 4. Fittings shall have continuous welds along all seams. Divided flow fittings shall be manufactured as separate fittings, not as tap collars welded into spiral duct sections.
 5. Ninety degree tees (conical) and 45 degree laterals (wye) up to and including 12" diameter tap size to have radius entrance into the tap, produced by machine or press forming. Entrances to be free of weld build-up, burrs, or irregularities.
 6. Elbows in diameters 3" thru 8" shall be two section stamped elbows. Other elbows shall be gored construction with all seams continuous welded. Fabricate to center line radius of 1.5 times the cross sectional diameter. Elbows, not die-stamped, shall be fabricated as follows:
 - a. a. Less than 30 degree angle: minimum 2 gores
 - b. b. Between 30 thru 60 degrees: minimum 3 gores
 - c. c. Over 60 degrees: minimum 5 gores
 7. Two piece mitered elbows shall not be used.
 8. Tees shall be conical. Saddle taps or straight tees shall not be used.
 9. The leading edge of all vanes in ducts over 20" diameter shall be hemmed with 1/2" foldback. Turning vanes in ducts over 24" shall be reinforced by stays or sectional construction to limit unsupported length to 24". Vanes shall be a minimum of 20 gauge.
 10. Reduction of divided flow fittings to conical span section in the 36 common reductions in sizes 4" thru 22".
 11. Spun bellmouth connections are to be used at each round take-off from plenum.

12. Galvanized areas damaged by welding to be coated with corrosion resistant aluminum paint.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Ducts, casings and hangers shall be installed straight and level and shall be free of vibration and noise when fans are operating at rated capacity.
- C. Install in accordance with manufacturer's instructions.
- D. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- E. Flexible Ducts: Connect to metal ducts with adhesive.
- F. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- H. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- I. Use double nuts and lock washers on threaded rod supports.
- J. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.

3.02 CLEANING

- A. Clean mechanical system thoroughly to assure all foreign matter, and dirt is removed.

3.03 LEAKAGE TESTING OF INSTALLED SYSTEMS

- A. All ductwork shall be leak tested in accordance with the procedures outlined in the SMACNA HVAC Air Duct Leakage Test Manual, Second Edition- 2012.
- B. Duct Systems may be tested in sections. Provide blank offs, temporary caps, etc. as required.
- C. Pressurize installed duct system to maximum pressure for fabrication classification. Total allowable leakage shall not exceed one percent of air handling capacity of system. If system is tested in sections, add leakage rates for individual sections to determine leakage for the whole system.
- D. Perform all tests prior to the installation of external duct insulation.
- E. Correct leaks found in excess of allowable limits. Retest.
- F. Submit Air Duct Leak Test Reports to the Architect and/or Engineer of Record for approval.
- G. Have test results available for review on a progressive and final basis. Include test results in project closing file.
- H. Testing in accordance with printed procedure.
- I. During Testing, Adjusting, and Balancing Procedures, if the ductwork is found to leak in excess of the allowable quantities, the ductwork shall be re-tested and repaired at the expense of the Sheet Metal Contractor.

3.04 AIR TEST AND BALANCE

- A. Prepare the system for tests as specified in Section 23 05 93 and correct deficiencies found by the Test and Balance firm.
- B. Duct dimensions shown on drawings indicate inside clear dimensions. Make allowances for duct requiring internal sound lining, or insulation to provide "inside clear" (IC) dimensions.

- C. In addition to the requirements above, add supplemental bracing as necessary to prevent sagging and drumming, and/or vibration.

END OF SECTION

SECTION 23 3300
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers - metal.
- C. Duct access doors.
- D. Duct test holes.
- E. Flexible ductwork.
- F. Flexible duct connections.
- G. Volume control dampers.

1.02 RELATED REQUIREMENTS

- A. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- B. Section 23 3100 - HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.
- B. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems; National Fire Protection Association; 2012.
- C. SMACNA (DCS) - HVAC Duct Construction Standards; 2005.
- D. SMACNA (DCS) - HVAC Duct Construction Standards, Metal and Flexible, Third Edition; 2005.

1.04 SUBMITTALS

- A. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
- B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.
- C. Project Record Drawings: Record actual locations of access doors and test holes.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS

- A. Manufacturers:
 - 1. Aero-Dyne Sound Control Company; High Efficiency Profile, H-E-P. www.aero-dyne.net
 - 2. Carlisle HVAC Products; Dynair Hollow Vane and Rail (Double Wall Vane): www.carlislehvac.com.
 - 3. Ruskin Company: www.ruskin.com.
 - 4. Titus: www.titus-hvac.com.
 - 5. Substitutions: See Section 01 6000 - Product Requirements. Proposed substitution shall include independent performance test data for pressure loss and generated sound power levels.

- B. Turning vanes shall be an engineered, true airfoil design with smoothly-rounded entry nose and extended trailing edge for high efficiency performance.
- C. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.02 BACKDRAFT DAMPERS - METAL

- A. Gravity Backdraft Dampers, Size 18 x 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.

2.03 DUCT ACCESS DOORS

- A. Manufacturers:
 - 1. Kees Incorporated: www.kees.com.
 - 2. Nailor Industries Inc: www.nailor.com.
 - 3. Ruskin Company: www.ruskin.com.
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Provide insulated doors in ductwork for access to service equipment such as duct mounted smoke detectors, duct mounted air flow measuring stations (each side) and elsewhere as noted on drawings.
- D. Size access doors as follows:
 - 1. Duct Sizes under 12": Door sized sufficient to service equipment or duct smoke detector
 - 2. Duct sizes 12" to 20": 12"x12" door
 - 3. Duct sizes 20" to 36": 18"x18" door
 - 4. Duct sizes 36" and above: 24"x24" door
- E. Apparatus casing access doors: Prehung door frame assemblies, size 24" x 60" Ruskin GPAD.
- F. Provide reinforced wire glass view windows, 12"x12", in access doors at humidifiers.
- G. Use double panel construction, two sheets of at least 24 gauge galvanized steel with 1" thick insulation between panels.
- H. Mount doors in a rigid frame of at least 22 gauge formed galvanized steel or aluminum.
- I. Use angle iron bracing as required to make the door frame a rigid assembly.
- J. Provide latches that permit easy removal of access door while maintaining positive closing and minimum leakage.
- K. Provide sponge rubber gaskets for all doors.
- L. In accordance with NFPA 90A, identify each access door with 1/2" high stenciled letters as 'Smoke Detector'.

2.04 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.
 - 1. Products:
 - a. Carlisle HVAC Products; Dynair Test Port with Red Cap with O-Ring Seal: www.carlislehvac.com.

2.05 FLEXIBLE DUCTWORK

- A. Manufacturers:
 - 1. Flexmaster U.S.A., Model No. Type 5M insulated: www.flexmasterusa.com.
 - 2. OmniAir, Model 1200: www.atcoflex.com.
 - 3. Thermaflex, Model MK-E insulated: www.thermaflex.net.

- B. Characteristics of flexible duct to air terminals:
 - 1. Approved as UL Class 1 air duct.
 - 2. Flame spread less than 25, smoke developed rating less than 50.
 - 3. Factory insulated with 1/2" thick fiberglass insulation.
 - 4. Provide a minimum of three feet of flexible duct upstream of diffusers. Do not exceed six feet of length.
 - 5. Flexible duct shall meet standards of local building code.
 - 6. For hospital critical areas, including Surgery, Recovery, Labor, Delivery, Nursery, LDRP, ICU, CCU and Trauma, use metal lined flexible ductwork, equivalent to OMNI 1800.
- C. Seal off the insulation jacket at its ends and at joints with mastic, hardcast, or similar material. Replace flex if jacket is punctured.
- D. Secure the core of flexible ducts to rigid duct and equipment collars with metallic adjustable clamping bands. Supplementarily secure the insulation and vapor barrier jacket with an additional clamping band.
- E. Flexible ducts less than 2'-0" long shall be supported with a minimum of one (1) hanger. Flexible ducts 2'-0" to 6'-0" long shall be supported with a minimum of two (2) hangers.
- F. Complete insulation coverage up to the boxes.
- G. Do not route flexible duct through corridor walls, fire or smoke partitions.
- H. No bends shall be made in flexible duct with the center line radius less than one and one-half duct diameter and only one bend may occur per four foot length of duct material.
- I. Flexible duct is not for use in exhaust ductwork systems.

2.06 FLEXIBLE DUCT CONNECTIONS

- A. Manufacturers:
 - 1. Carlisle HVAC Products; Dynair Connector Plus G90 Steel Offset Seam Neoprene Fabric: www.carlislehvac.com.
- B. Provide flexible connections for all equipment which is furnished with motor driven fans, whether or not the fans are internally isolated or flexible coupled.
- C. Provide flexible connections in the ductwork where the ducts cross building expansion joints.
- D. Fabricate in accordance with SMACNA (DCS) and as indicated.
- E. Flexible Duct Connections: Fabric crimped into metal edging strip.
 - 1. Fabric: UL listed fire-retardant neoprene double coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
 - a. Net Fabric Width: Approximately 2 inches wide.
- F. Maximum Installed Length: 14 inch.

2.07 VOLUME CONTROL DAMPERS

- A. Manufacturers:
 - 1. Nailor Industries Inc: www.nailor.com.
 - 2. Ruskin Company: www.ruskin.com.
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Splitter Dampers:
 - 1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
 - 2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 - 3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw .

- D. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.
 - 1. Fabricate for duct sizes up to 6 x 30 inch.
 - 2. Blade: 24 gage, 0.0239 inch, minimum.
- E. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped 3V type blades in prime coated or galvanized channel frame with suitable hardware.
 - 1. Blade: 18 gage, 0.0478 inch, minimum.
- F. Shaft: 1/2" square rod operator with end bearings and gasket seal at duct penetrations. Terminate shaft in damper frame with bushings.
- G. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.
 - 1. Products:
 - a. Carlisle HVAC Products; Dynair End Bearing Leak Resistant Sets:
www.carlislehvac.com.
- H. Quadrants:
 - 1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 - 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
 - 3. Where rod lengths exceed 30 inches provide regulator at both ends.
 - 4. Products:
 - a. Carlisle HVAC Products; Dynair Double Shear Rattle Free Quadrants 1/2 inch:
www.carlislehvac.com.

2.08 MISCELLANEOUS PRODUCTS

- A. Duct Opening Closure Film: Mold-resistant, self-adhesive film to keep debris out of ducts during construction.
 - 1. Thickness: 2 mils.
 - 2. High tack water based adhesive.
 - 3. UV stable light blue color.
 - 4. Elongation Before Break: 325 percent, minimum.
 - 5. Products:
 - a. Carlisle HVAC Products; Dynair Duct Protection Film: www.carlislehvac.com.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Install accessories in locations shown on drawings and in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards. Refer to Section 23 3100 for duct construction and pressure class.
- B. Provide all screws, bolts, nuts, inserts, and material required for attaching sheet metal to duct, walls, floors, and ceilings.
- C. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- D. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, size for shoulder access, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.
- E. Provide duct test holes where indicated and required for testing and balancing purposes.

- F. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
- G. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment; see Section 22 0548.
- H. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- I. Where diffusers or grilles and registers are not provided with volume dampers, install spin-in fitting with balancing damper in duct runout.
- J. Use splitter dampers only where indicated.
- K. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

3.03 TESTING

- A. Check work for satisfactory installation and performance.
- B. Insure that adequate access does in fact exist for fire and smoke dampers and that damper operator motors are not hindered in operation by proximity to walls or other objects.
- C. Check duct connections at access doors for air leakage or condensation. Correct conditions found.

END OF SECTION

SECTION 23 3423
HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Roof exhausters.

1.02 RELATED REQUIREMENTS

- A. Section 23 0513 - Common Motor Requirements for HVAC Equipment.
- B. Division 26 - Electrical

1.03 REFERENCE STANDARDS

- A. AMCA 99 - Standards Handbook; Air Movement and Control Association International, Inc.; 2010.
- B. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2005.
- C. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating; Air Movement and Control Association International, Inc.; 2007 (ANSI/AMCA 210, same as ANSI/ASHRAE 51).
- D. AMCA (DIR) - [Directory of] Products Licensed Under AMCA International Certified Ratings Program; Air Movement and Control Association International, Inc.; <http://www.amca.org/certified/search/company.aspx>.
- E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; Air Movement and Control Association International, Inc.; 2008.
- F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; Air Movement and Control Association International, Inc.; 2007.

1.04 PERFORMANCE

- A. Certify fans performance in accordance with AMCA Certified Air and Sound Rating Criteria, Standard 210, 300, and 301.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- C. For Exterior Mounted Fans: Current Miami-Dade Notice of Acceptance information including installation instructions to meet project wind load requirements. The mechanical contractor shall hire a structural professional engineer registered in the State of Florida as required to provide structural tie-down and/or connection details to ensure roof curb and/or fan system installation meet project wind load requirements as dictated by the Florida Building Code.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Greenheck: www.greenheck.com.
- B. Loren Cook Company: www.lorencook.com.
- C. PennBarry: www.pennbarry.com.

2.02 POWER VENTILATORS - GENERAL

- A. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.
- B. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.

- C. Sound Ratings: AMCA 301, tested to AMCA 300, and bearing AMCA Certified Sound Rating Seal.
- D. Fabrication: Conform to AMCA 99.
- E. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.03 ROOF EXHAUSTERS

- A. Fan Unit: Variable pitch V-belt or direct driven as indicated, with heavy gauge spun aluminum housing enclosing motor outside airstream; centrifugal type, statically and dynamically balanced, resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
- B. Motor: Ball bearing type, designed for heavy duty vertical mounting. Isolate motors and fans from base with rubber isolators. Select motor such that motor BHP does not exceed nameplate at rated conditions.
- C. Roof Curb: 12 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.
- D. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor .
- E. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.
- F. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- G. Provide:
 - 1. Lubricated lifetime sealed ball bearings.
 - 2. Sparkproof constructions with explosion proof motor suitable for Class I, Group C, Division 33 service, where scheduled on drawings.
 - 3. Gravity dampers where not specified to be motorized.
 - 4. Motorized backdraft dampers interlocked as shown in control drawings.
 - 5. Disconnect switch on 3-phase units furnished under Division 26, unless noted as a fan accessory on fan schedule.
 - 6. Bird screen around fan discharge.
 - 7. Where required, prefabricated 1" thick fiberglass insulated, roof curb of same material as fan housings and manufactured by the fan manufacturer. Provide minimum 12" high curb; see Mechanical Schedules on drawings. Refer to Architectural Drawings for roof pitch.
 - 8. Upblast housing where shown on drawings.

PART 3 EXECUTION

3.01 INSTALLATION - ROOF MOUNTED FANS

- A. Install fans in accordance with manufacturer's instructions.
- B. Connect and test electrical connections under Division 26.
- C. Secure roof exhausters with stainless steel lag screws to roof curb.
- D. Extend ducts to roof exhausters into roof curb. Provide flexible connections (minimum of four inches) between fan and duct. Counterflash duct to roof opening.
- E. Install fan level - plus or minus five (5) degrees in vertical. Final installation to be free of all leaks both from fan interior and roof-to-curb interface.
- F. Install backdraft dampers on inlet to roof exhausters.

3.02 INSTALLATION - WALL MOUNTED FANS

- A. Install fans in accordance with manufacturer's instructions.
- B. Connect and test electrical connections under Division 26.
- C. Install backdraft dampers on inlet to wall exhausters.

3.03 START-UP, TESTING, DEMONSTRATION

- A. Start-up fans after checkout to ensure proper alignment and phased electrical connections.
- B. Test fans individually and as part of a system, where required, in accordance with Section 23 0500.
- C. Where required, ensure that fans are interlocked with supply and/or return fans and with fire detection and control system.
- D. Demonstrate and instruct operation to maintenance personnel.

END OF SECTION

SECTION 23 3700
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Diffusers.
- B. Registers/grilles.

1.02 RELATED REQUIREMENTS

- A. Section 09 9123 - Interior Painting: Painting of ducts visible behind outlets and inlets.

1.03 REFERENCE STANDARDS

- A. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Inlets; American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.; 2006 (R2011).
- B. SMACNA (DCS) - HVAC Duct Construction Standards; 2005.

1.04 SUBMITTALS

- A. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

1.05 QUALITY ASSURANCE

- A. Air diffusers, grilles, and registers: Ratings certified by Air Diffusion Council.
- B. Roof Ceiling Assembly: Comply with requirements of UL Fire Resistance Index.
- C. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Metal-Aire: www.metalindustriesinc.com.
- B. Price Industries: www.price-hvac.com.
- C. Titus: www.titus-hvac.com.

2.02 GENERAL

- A. Ceiling diffusers, grilles and registers shall be of steel or aluminum construction in accordance with the roof/ceiling assembly as detailed in the UL Fire Resistance Index.

2.03 RECTANGULAR CEILING DIFFUSERS

- A. Square Louvered Face Directional Ceiling Diffuser: Metal-Aire Model Series 5200 or Price Model AMD or Titus Model TDC-AA. Diffuser shall be four way directional. For diffusers noted on drawings to be 1, 2 or 3 way blow, provide appropriate core in diffuser.
- B. Coordinate ceiling device frame type with architectural ceiling type.
- C. Ceiling diffusers may be suitable for lay-in tile installation by mounting it in a factory fabricated, 24"x24" panel, only if diffuser face is a minimum of 15"x15". Provide Frame style 3.
- D. Fabrication: Aluminum with baked enamel finish.
- E. Color: As selected by architect.
- F. Provide ceiling diffusers complete with opposed blade volume dampers where diffuser is installed in inaccessible ceilings. Do not furnish volume damper for diffusers installed in accessible ceilings or exposed diffusers.

2.04 CEILING EGG CRATE EXHAUST AND RETURN GRILLES

- A. Metal-Aire Model CC5-8 or Price Model 85-F or Titus Model 50-F.

- B. Type: Egg crate style face consisting of 1/2 x 1/2 x 1/2 inch grid core.
- C. Color: As selected by architect
- D. Coordinate ceiling device frame type with architectural ceiling type.
- E. Provide grille complete with opposed blade volume dampers where installed in inaccessible ceilings. Do not furnish volume damper for grilles installed in accessible ceilings or exposed registers.

2.05 WALL SUPPLY REGISTERS/GRILLES

2.06 WALL SUPPLY REGISTERS/GRILLES

- A. Metal-Aire Model equivalent or Price Model 620D or Titus Model equivalent.
- B. Selected at no more than NC 20 for airflow shown on drawings.
- C. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical face, double deflection.
- D. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- E. Color: As shown on the drawings.
- F. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

2.07 WALL EXHAUST AND RETURN REGISTERS/GRILLES

- A. Metal-Aire Model equivalent or Price Model 630D or Titus Model equivalent.
- B. Selected at no more than NC 20 for airflow shown on drawings.
- C. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, vertical face.
- D. Frame: 1-1/4 inch margin with countersunk screw mounting.
- E. Fabrication: Steel frames and blades, with factory baked enamel finish.
- F. Color: As shown on the drawings.
- G. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- C. Install diffusers to ductwork with air tight connection.
- D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- E. Where diffusers or grilles and registers are not provided with volume dampers, install spin-in fitting with balancing damper in duct runout.
- F. Provide all screws, bolts, nuts, inserts, and material required for attaching sheet metal to duct, walls, floors, and ceilings.
- G. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 9123.

END OF SECTION

SECTION 23 4000
HVAC AIR CLEANING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Disposable panel filters.

1.02 REFERENCE STANDARDS

- A. AHRI 850 - Performance Rating of Commercial and Industrial Air Filter Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2004.
- B. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2012.
- C. UL 900 - Standard for Air Filter Units; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.03 PERFORMANCE REQUIREMENTS

- A. Conform to AHRI 850 Section 7.4.

1.04 SUBMITTALS

- A. See Section 01 300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.
- C. Operation and Maintenance Data: Include instructions for operation, changing, and periodic cleaning.

1.05 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 FILTER MANUFACTURERS

- A. American Filtration Inc: www.americanfiltration.com.
- B. AAF International/American Air Filter: www.aafintl.com.
- C. Camfil Farr Company: www.camfilfarr.com.

2.02 DISPOSABLE PANEL FILTERS

- A. Media: UL 900 Class 2, fiber blanket, factory sprayed with flameproof, non-drip, non-volatile adhesive.
 - 1. Minimum MERV 7.
 - 2. Thickness: 2 inch.
- B. Performance Rating:
 - 1. Face Velocity: 500 FPM.
 - 2. Initial Resistance: 0.15 inch WG.
 - 3. Recommended Final Resistance: 0.50 inches WG.
- C. Holding Frames: 20 gage, 0.0359 inch minimum galvanized steel frame with expanded metal grid on outlet side and steel rod grid on inlet side, hinged with pull and retaining handles.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install air cleaning devices in accordance with manufacturer's instructions.
- B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.

- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

END OF SECTION

SECTION 23 7413

PACKAGED OUTDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Packaged roof top unit.
- B. Unit controls.
- C. Roof mounting curb and base.
- D. Maintenance service.

1.02 RELATED REQUIREMENTS

- A. Section 07 6200 - Sheet Metal Flashing and Trim.
- B. Section 06 105 - Miscellaneous Carpentry.
- C. Division 26 - Electrical.

1.03 REFERENCE STANDARDS

- A. AHRI 210/240 - Standard for Performance Rating of Unitary Air Conditioning and Air-Source Heat Pump Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.
- B. AHRI 270 - Sound Rating of Outdoor Unitary Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.
- C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilation Systems; National Fire Protection Association; 2012.

1.04 SUBMITTALS

- A. See Section 01 300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
- C. Shop Drawings: Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
- D. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.
- E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from physical damage by storing off site until roof mounting curbs are in place, ready for immediate installation of units.

1.07 WARRANTY

- A. See Section 01 740 - Closeout Submittals, for additional warranty requirements.
- B. Provide a five year warranty to include coverage for refrigeration compressors.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Trane Inc: www.trane.com.
- B. York by Johnson Controls Inc: www.johnsoncontrols.com.

2.02 PERFORMANCE REQUIREMENTS

- A. Scheduled Performance:
 - 1. Cooling capacity: AHRI 210/240 test conditions.
 - 2. Sound Rating Numbers: AHRI 270.

2.03 MANUFACTURED UNITS

- A. General: Roof mounted units having electric heating elements and electric refrigeration.
- B. Description: Self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, electric heating elements, controls, air filters, refrigerant cooling coil and compressor, condenser coil and condenser fan.
- C. Disconnect Switch: Factory mount disconnect switch in control panel.

2.04 FABRICATION

- A. Cabinet: Steel with baked enamel finish, including access panels with screwdriver operated flush cam type fasteners. Structural members shall be minimum 18 gage, 0.0478 inch, with access doors or panels of minimum 20 gage, 0.0359 inch.
- B. Supply Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, adjustable variable pitch motor pulley, and rubber isolated hinge mounted high efficiency motor or direct drive as indicated. Isolate complete fan assembly. Refer to Section 23 0548.
- C. Air Filters: 2 inch thick glass fiber disposable media in metal frames. Refer to Section 23 4000.
- D. Roof Mounting Curb: Minimum 18 inches high galvanized steel, channel frame with gaskets, nailer strips.
 - 1. Curb shall be wind rated for project.

2.05 ELECTRIC HEATING COIL

- A. Finned tube heating elements easily accessible with automatic reset thermal cut-out, built-in magnetic contactors, galvanized steel frame, control circuit transformer and fuse, manual reset thermal cut-out, airflow proving device, toggle switch (pilot duty), load fuses.
- B. Controls: Start supply fan before electric elements are energized and continue operating until air temperature reaches minimum setting, with switch for continuous fan operation.

2.06 EVAPORATOR COIL

- A. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.
- B. Provide capillary tubes or thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.

2.07 COMPRESSOR

- A. Provide hermetic compressors, 3600 rpm maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gage ports, and filter drier.
- B. For heat pump units, provide reversing valve, suction line accumulator, discharge muffler, flow control check valve, and solid-state defrost control utilizing thermistors.

2.08 CONDENSER COIL

- A. Provide copper tube aluminum fin coil assembly with subcooling rows and coil guard.

- B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Provide high efficiency fan motors.

2.09 MIXED AIR CASING

- A. Dampers: Provide motorized outside and return air dampers for fixed outside air quantity. Dampers shall fail in closed position.
- B. Gaskets: Provide tight fitting dampers with edge gaskets.

2.10 OPERATING CONTROLS - SINGLE ZONE UNITS

- A. Electric solid state microcomputer based room thermostat, located as indicated in service area with remote sensor located as indicated.
- B. Room thermostat shall incorporate:
 - 1. Automatic switching from heating to cooling.
 - 2. Preferential rate control to minimize overshoot and deviation from set point.
 - 3. Set-up for four separate temperatures per day.
 - 4. Instant override of set point for continuous or timed period from one hour to 31 days.
 - 5. Short cycle protection.
 - 6. Programming based on weekdays, Saturday and Sunday.
 - 7. Switch selection features including imperial or metric display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto.
- C. Room thermostat display shall include:
 - 1. Time of day.
 - 2. Actual room temperature.
 - 3. Programmed temperature.
 - 4. Programmed time.
 - 5. Duration of timed override.
 - 6. Day of week.
 - 7. System model indication: heating, cooling, auto, off, fan auto, fan on.
 - 8. Stage (heating or cooling) operation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.
- B. Verify that proper power supply is available.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Mount units on factory built roof mounting curb providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.

3.03 SYSTEM STARTUP

- A. Prepare and start equipment. Adjust for proper operation.

3.04 CLOSEOUT ACTIVITIES

- A. Demonstrate operation to Owner's maintenance personnel.

3.05 MAINTENANCE

- A. See Section 01 700 - Execution Requirements, for additional requirements relating to maintenance service.
- B. Provide service and maintenance of packaged roof top units for one year year from Date of Substantial Completion.

- C. Provide routine maintenance service with a two month interval as maximum time period between calls.
- D. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibration.
- E. After each service call, submit copy of service call work order or report that includes description of work performed.

END OF SECTION

SECTION 23 8127
SMALL SPLIT-SYSTEM HEATING AND COOLING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air cooled condensing units.
- B. Indoor air handler (fan & coil) units for duct connection.
- C. Indoor ductless fan & coil units.
- D. Controls.

1.02 RELATED REQUIREMENTS

- A. Section 23 3100 - HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

- A. AHRI 210/240 - Standard for Performance Rating of Unitary Air Conditioning and Air-Source Heat Pump Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.
- B. AHRI 270 - Sound Rating of Outdoor Unitary Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.
- C. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; Air-Conditioning, Heating, and Refrigeration Institute; 2004.
- D. ASHRAE Std 23.1 - Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Temperatures of the Refrigerant; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010.
- E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.
- F. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems; National Fire Protection Association; 2012.
- G. UL 207 - Refrigerant-Containing Components and Accessories, Nonelectrical; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Trane Inc: www.trane.com.
- B. York International Corporation / Johnson Controls: www.york.com.
- C. Mitsubishi Electric: www.mehvac.com.

2.02 SYSTEM DESIGN

- A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
 - 1. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.

- B. Performance Requirements: See Drawings for additional requirements.
- C. Electrical Characteristics:
 - 1. 208 volts, single phase, 60 Hz.
 - 2. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 26 2717.

2.03 INDOOR UNITS FOR DUCTED SYSTEMS

- A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heating and cooling element(s), controls, and accessories; wired for single power connection with control transformer.
 - 1. Air Flow Configuration: Horizontal.
 - 2. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
- B. Supply Fan: Centrifugal type rubber mounted with direct or belt drive with adjustable variable pitch motor pulley.
 - 1. Motor: NEMA MG 1; 1750 rpm multiple speed, permanently lubricated, hinge mounted.
 - 2. Motor Electrical Characteristics:
- C. Air Filters: 1 inch thick minimum urethane, washable or glass fiber disposable type arranged for easy replacement.
- D. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
 - 1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
 - 2. Manufacturers: System manufacturer.

2.04 INDOOR UNITS FOR DUCTLESS SYSTEMS

- A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.
 - 1. Location: High-wall.
 - 2. Fan: Line-flow fan direct driven by a single motor.
 - 3. Filter return air with washable, antioxidant pre-filter and a pleated anti-allergy enzyme filter.
- B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
 - 1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
 - 2. Manufacturer: System manufacturer.
- C. Remote Actuators:

2.05 OUTDOOR UNITS

- A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
 - 1. Comply with AHRI 210.
 - 2. Refrigerant: R-410A.
 - 3. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23.1 and UL 207.
 - 4. Sound Rating: 69 dBA, when measured in accordance with AHRI 270.
- B. Compressor: AHRI 520; hermetic, two speed 1800 and 3600 rpm, resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.

- C. Air Cooled Condenser: ARI 520; Aluminum fin and copper tube coil, with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
 - 1. Condenser Fans: Direct-drive propeller type.
 - 2. Condenser Fan Motor: Enclosed, 1-phase type, permanently lubricated.
- D. Coil: Air-cooled, aluminum fins bonded to copper tubes.
- E. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gage ports, thermometer well (in liquid line).
 - 1. Provide thermostatic expansion valves.
 - 2. Provide heat pump reversing valves as applicable.
- F. Operating Controls:
 - 1. Control by room thermostat to maintain room temperature setting.

2.06 ACCESSORY EQUIPMENT

- A. Room Thermostat: Wall-mounted, electric solid state microcomputer based room thermostat with remote sensor to maintain temperature setting; low-voltage; with following features:
 - 1. Automatic switching from heating to cooling.
 - 2. Preferential rate control to minimize overshoot and deviation from setpoint.
 - 3. Programming based on weekdays, Saturday and Sunday.
 - 4. Selection features including degree F or degree C display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto.
 - 5. Battery replacement without program loss.
 - 6. Thermostat display:
 - a. Actual room temperature.
 - b. Programmed temperature.
 - c. System mode indication: heating, cooling, fan auto, off, and on, auto or on, off.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.
- B. Verify that proper power supply is available and in correct location.
- C. Verify that proper fuel supply is available for connection.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.
- B. Install in accordance with NFPA 90A and NFPA 90B.

END OF SECTION

SECTION 26 0500
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 specification Sections apply to all Division 26 sections.
- B. Furnish and install electrical systems, materials, equipment, and accessories in accordance with this specifications and drawings.

1.02 RELATED REQUIREMENTS

- A. Section 23 0000 - Heating, Ventilating, and Air-Conditioning.
- B. Section 22 0000 - Plumbing.

1.03 SUBMITTALS

- A. The Engineer's approval shall be obtained for all equipment and materials before delivery to the job site. Delivery, storage or installation of equipment and materials which has not had prior approval will not be permitted.
- B. All submittals shall include 2 copies of adequate descriptive literature, catalog, shop drawings, test reports, certifications, samples, and other data necessary to ascertain that the proposed equipment and materials comply with drawings and specifications requirements

1.04 REFERENCE STANDARDS

- A. Perform Work specified in Division 26 in accordance with standards listed below of the latest applicable edition adopted by the authority having jurisdiction. The Drawings and Specifications shall take precedent in those instances where requirements are greater than those stated in the below codes and standards. In case of conflict, obtain a decision from the Engineer.
- B. Florida Building Code (2010)
- C. NFPA 1: Fire Code (2009)
- D. NFPA 70: National Electrical Code (2011)
- E. NFPA 72: National Fire Alarm Code (2010)
- F. NFPA 90A: Standard for the Installation of Air Conditioning and Ventilating Systems (2012)
- G. NFPA 101: Life Safety Code (2012)
- H. NFPA 241: Standard for Safeguarding Building Construction, Alteration and Demolition Operations (2009)
- I. NFPA 5000 - Building Construction and Safety Code; 2012
- J. City of CLEARWATER Electrical Code
- K. Other standards:
 - 1. ANSI
 - 2. ASME
 - 3. ASHRAE
 - 4. ASTM
 - 5. IEEE
 - 6. IESNA
 - 7. NECA
 - 8. NEMA
 - 9. OSHA
 - 10. UL

1.05 QUALITY ASSURANCE

- A. Comply with applicable local, state, and federal codes.

- B. Warrant electrical Work against faulty material or Workmanship in accordance with Division 01. If the Project is occupied or the systems placed in operation in several phases at the request of the Owner's Representative, then the warranty of each system or piece of equipment used, shall begin on the date each system or piece of equipment was placed in satisfactory operation and accepted as such, in writing, by the Owner's Representative. The use of building equipment for temporary service and testing does not constitute the beginning of the warranty.
- C. Upon completion of contract and progressively as work proceeds, clean-up and remove dirt, debris and scrap materials. Maintain premises neat and clean. Protect and preserve access to energized equipment at all times. Clean items with factory finishes. Touch-up minor damage to surfaces; refinish entire piece of equipment when sustained major damage. Use only factory supplied paints of matching color and formula. Schedule an off-hour shutdown of all electrical equipment during the 2-week period preceding substantial completion. During this shut down, clean all buses and insulators inside all switchgear, switchboards, bus ducts, collector buses and panelboards located inside or adjacent to the project limits.

1.06 QUALIFICATIONS (PRODUCT AND SERVICES)

- A. Manufacturer's Qualifications: The manufacturer shall regularly and currently produce, as one of the manufacturer's principal products, the equipment and materials specified for this project, and shall have manufactured the equipment and materials for at least three years.
- B. Product Qualification:
 - 1. Manufactured equipment and materials shall have been in satisfactory operation, on three installation of similar size and type as this project at least for three years.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment and materials in manufacturer's original unopened packaging. Equipment and materials shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fume, moisture, cold, and rain. Evidence of damage from water or other contaminants will be cause of rejection.
 - 1. Store equipment and materials indoors in clean dry space with uniform temperature to prevent condensation.
 - 2. During installation, equipment shall be protected against entry of instances matter, and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.
 - 3. Damaged equipment shall be repaired or replaced, as determined by the Engineer.
 - 4. Painted surfaces shall be protected with factory installed removable heavy craft paper, sheet vinyl or equal.
 - 5. Damaged paint on equipment shall be refinished with the same quality of paint as used by manufacturer so repaired areas are nt obvious.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. All equipment and materials shall be listed, labeled, or certified by a Nationally Recognized Testing Laboratory (NRTL) to meet Underwrites Laboratories, UL. (UL), standards where standards have been established. Equipment and materials which are not covered by UL standards will be accepted, providing that equipment and materials are listed, labeled, certified or otherwise determined to meet the safety requirements of a NRTL. Equipment and materials not listed, labeled or determined to be safe will be considered if submitted according to Drawings, Specifications, and industry standards and shall be approved by the authorities having jurisdiction.
- B. Specifications and Drawings indicate name, type and/or catalog number of materials and equipment to establish standards of quality. Submittals shall be based on the standards specified. The standards should not be construed as limiting competition.

- C. If equipment and materials other than specified herein are intended to be submitted, a letter providing a list of all the suggested alternates by section number, brand and series or model shall be submitted to the Engineer for review and approval. Submit in accordance with Division 01 and a minimum of 14 days prior to submission for bids.

PART 3 - EXECUTION

3.01 COORDINATION

- A. Install equipment in accordance with manufacturer's recommendations. Where conflicts occur between Contract Documents and these recommendations, request a ruling before proceeding with such Work.
- B. Visit site and observe conditions under which work must be performed. No subsequent allowance will be made because of error or failure to obtain necessary information to completely estimate and perform work required by these documents.
- C. Examine Specifications and Drawings to be familiar with items which require electrical connections and coordination. Electrical Drawings are diagrammatic and shall not be scaled for exact sizes.

3.02 FEES AND PERMITS

- A. Obtain and pay for all necessary permits and inspection fees required for electrical installation.

3.03 TEMPORARY LIGHTS AND POWER

- A. Provide a temporary electrical lighting and power distribution system of adequate size to properly serve the following requirements, including adequate feeder sizes to prevent excessive voltage drop. Temporary Work shall be installed in a neat and safe manner in accordance with the National Electrical Code, Article 305, NFPA 241, and as required by OSHA or applicable local safety codes.
- B. Provide one pigtail socket with 150 watt lamp, CFL medium base, for every 1,000 square feet of floor area, evenly distributed throughout the building and with minimum of one pigtail socket per room.
- C. Provide suitable guards for temporary lights to prevent accidental contact with lamps.
- D. Provide a minimum of one GFCI-protected duplex power outlet for every 1,500 square feet of floor area, evenly distributed throughout the building. Power outlets shall be GFCI-protected duplex 20 amp, 120 volt.
- E. Provide feeders, disconnects, connections, etc., required for construction equipment, e.g., cranes, pumps, etc.
- F. Provide service and panelboards required for above lighting and power outlets.
- G. Requirement for payment of utility bills during construction are specified in Division 01.
- H. Provide single phase and three phase service as required by Project.
- I. Remove temporary wiring upon completion of use.

3.04 CUTTING AND PATCHING

- A. Comply with provisions of Division 01
- B. Repair or replace routine damage caused by cutting in performance of Work under this Division.
- C. Correct unnecessary damage caused due to installation of electrical Work, brought about through carelessness or lack of coordination.
- D. Holes cut through walls shall be drilled or cut with tools designed for the purpose. All openings, sleeves and holes in walls that extend to underside of floor above shall be properly sealed and fire proofed.
- E. Contractor shall not be permitted to cut or modify any structural members without the written permission of the Architect .

3.05 TRENCHING, EXCAVATION, BACKFILLING, AND REPAIRS

- A. Provide trenching, excavation, and backfilling necessary for performance of Work under this Division.
- B. Trenching and excavation shall be unclassified. No extra will be paid in event that rock is encountered.

3.06 FOUNDATIONS AND PADS

- A. Provide concrete foundations and pads as required for electrical utility company's equipment such as transformers, CT cabinets, metering cabinets, switches, fused disconnects, and circuit breakers. All work shall be in compliance with the utility company's specifications.

3.07 UTILITY COMPANY COORDINATION

- A. Electrical service entrance equipment and arrangements for temporary and permanent connection to the utility company electrical system shall conform to the electrical utility company specifications. Coordinate with the utility company as to all types of work required to be done by the contractor for the utility company equipment.
- B. Confirm exact location of point of common coupling, duct banks, pads, etc.
- C. Obtain copies of all pertinent utility company specifications relating to duct banks, concrete pads, raceways, and cable that are contractor installed for the utility company use. Maintain copies at project site.
- D. Install all components in compliance with utility company specifications and project specifications.

3.08 TESTING ELECTRICAL SYSTEMS

- A. On completion of work, installation shall be completely operational and entirely free from grounds, short circuits, and open circuits. Perform operational tests as required to demonstrate substantial completion of the Work. Balance circuits so that feeders to panels are not more than 10% out of balance between phases with all available load energized and operating. Furnish all labor, materials and instruments for above tests. All ampere readings shall be made with a true RMS reading meter.
- B. Perform megger tests of all service entrance circuits, feeder and branch circuits size #4 AWG and larger. Provide a report of all such megger test results.
- C. Service ground resistance test
- D. Prior to final observation and acceptance test, install all electrical systems and equipment complete and in satisfactory operating condition.

END OF SECTION

SECTION 26 0501
MINOR ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical demolition.
- B. Comply with provision of Section 26 0500 Common Work Results for Electrical.
- C. Basic materials and methods, along with Division 01, General Requirements, that are applicable to all Division 26 sections

1.02 RELATED REQUIREMENTS

- A. Section 01 7000 - Execution and Closeout Requirements: Additional requirements for alterations work.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Visit the site to observe existing conditions before submitting a bid.
- B. Verify field measurements and circuiting arrangements are as shown on Drawings.
- C. Verify that abandoned wiring and equipment serve only abandoned facilities.
- D. Report discrepancies to Engineer before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

- A. Work in existing buildings shall be scheduled well in advance with the Owner's Representative. Work shall be performed at such times and under such conditions as suit the convenience of the Owner's Representative. Plan the Work to minimize disruption of normal operations. Notify Owner's Representative before any circuit is de-energized in occupied areas.
- B. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- C. Coordinate utility service outages with utility company.
- D. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- E. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

- D. Where a circuit is interrupted by removal of a device or fixture from that circuit, install wire and conduit as required to restore service to the remaining devices and fixtures on that circuit. Ensure proper grounding is maintained.
- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- F. Disconnect and remove abandoned panelboards and distribution equipment.
- G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- I. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.
- J. Lighting fixtures, wiring devices, panelboards, equipment, conduits and conductors removed shall be transported to the Owner's designated location and offered to the OWNER. If he chooses to retain these items or a part of these items, turn those chosen over to him. Items rejected by the OWNER shall be removed completely from the project site and disposed of legally by the CONTRACTOR.

3.04 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or that are to be reused.

END OF SECTION

SECTION 26 0519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 specification Sections apply to to this Section.
- B. Comply with provision of Section 26 0500 Common Work Results for Electrical.
- C. Furnish and install electrical systems, materials, equipment, and accessories in accordance with this specifications and drawings

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 26 0500 - Common Work Results for Electrical.
- C. Section 26 0501 - Minor Electrical Demolition: Disconnection, removal, and/or extension of existing electrical conductors and cables.
- D. Section 26 0526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- E. Section 26 0534 - Raceways and Conduit Systems.
- F. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- C. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- D. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- E. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- F. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- G. UL 493 - Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables; Current Edition, Including All Revisions.
- H. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 3. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Furnish wires and cables on reels or coils factory-wrapped with waterproof flexible covering to protect against physical damage. Each cable and the outside of each reel or coil, shall be plainly marked or tagged to indicate the cable length, voltage rating, conductor size, and manufacturer's lot number and reel number. Each coil or reel shall contain only one continuous cable without splices. Damaged cable, wire or connectors shall be removed from project site.
- B. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Metal-clad cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:
 - a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
 - 1) Maximum Length: 6 feet.
 - b. Where concealed in hollow stud walls, above accessible ceilings, and under raised floors for branch circuits up to 20 A.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Conductor Material:
 - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.
- E. Minimum Conductor Size: 12 AWG.
 - 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 2. Control Circuits: 14 AWG.
- F. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- G. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Install in each branch circuit panelboard a legend explaining the color code for ungrounded conductors

3. Color Coding Method: Integrally colored insulation.
4. Color Code:
 - a. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral : White.
 - 5) Ground : Green.
 - 6) Isolated Ground: Green with Yellow stripe.
 - b. Travelers for 3-Way and 4-Way Switching: Pink.
 - c. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
 - d. For control circuits, comply with manufacturer's recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

- A. Description: Single conductor insulated wire.
- B. Conductor Stranding:
 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: solid.
 - b. Size 8 AWG and Larger: Stranded.
 2. Control Circuits: solid.
- C. Insulation:
 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
 - a. Size 4 AWG and Larger: Type THHN/THWN.
 - b. Installed Underground: Type XHHW-2.
 - c. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.

2.04 METAL-CLAD CABLE

- A. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
- B. Conductor Stranding:
 1. Size 10 AWG and Smaller: Solid.
 2. Size 8 AWG and Larger: Stranded.
- C. Insulation Voltage Rating: 600 V.
- D. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
- E. Grounding: Full-size integral equipment grounding conductor.
- F. Armor: Steel, interlocked tape.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.
- B. Complete conduit system, including bushings, before pulling wires or cables.

3.02 INSTALLATION

- A. Circuiting Requirements:
 1. Arrange circuiting to minimize splices.
 2. Include circuit lengths required to install connected devices within 10 ft of location shown.

3. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is not permitted.
 - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
 - b. Increase size of conductors as required to account for ampacity derating.
 - c. Size raceways, boxes, etc. to accommodate conductors.
 4. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
- B. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.
 - C. Install metal-clad cable (Type MC) in accordance with NECA 120.
 - D. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
 1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
 - E. Terminate cables using suitable fittings.
 1. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
 - F. Install conductors with a minimum of 12 inches of slack at each outlet.
 - G. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.
 - H. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
 - I. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
 - J. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
 - K. Identify conductors and cables in accordance with Section 26 0553.
 - L. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
 - M. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.03 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Electrical tests:
 1. After installation but before connection to utilization devices, such as fixtures, motors, or appliances, test conductors phase-to-phase and phase-to-ground resistance with an insulation resistance tester. Existing conductors to be reused shall also be tested.
 2. Applied voltage shall be 500 V DC for 300 V rated cable, and 1000 V DC for 600 V rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300 V rated cable and 100 megohms for 600 V rated cable.

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- a. Feeder (600A & smaller) circuits and branch circuits
 - 1) Use either a motor driven (Biddle 359) or a hand crank (Biddle MJ159) megger.
 - 2) Perform a dielectric absorption ratio test using a 60-second test period. Record the megohm readings at 30 seconds and 60 seconds. Calculate the dielectric absorption ratio (60 sec / 30 sec readings) and record
 - C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
 - 1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with new SPDs.
 - D. Correct deficiencies and replace damaged or defective conductors and cables.
 - E. Provide 2 copies of the megger test report to the Engineer. The report shall be in a tabulated format and shall include the following as a minimum.
 - 1. Circuit identification
 - 2. Type of raceway
 - 3. Approximate length of circuit
 - 4. Megohm readings

END OF SECTION

SECTION 26 0526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Comply with provision of Section 26 0500 Common Work Results for Electrical.
- B. This section specifies the furnishing, installation, connection, and testing of grounding and bonding equipment, indicated as grounding equipment in this section.
- C. "Grounding electrode system" refers to grounding electrode conductors and all electrodes required or allowed by NEC, as well as made, supplementary, and lightning protection system grounding electrodes.
- D. Ground access wells.

1.02 REFERENCE STANDARDS

- A. IEEE 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System; 2012.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; National Electrical Manufacturers Association; 2007.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).
- E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. NFPA 780 - Standard for the Installation of Lightning Protection Systems; National Fire Protection Association; 2014.
- G. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions, 2007

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- D. Equipment grounding conductors shall be insulated stranded copper, except that sizes No. 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all

- equipment grounding conductors, except that wire sizes No. 4 AWG and larger shall be identified per NEC.
- E. Bonding conductors shall be bare stranded copper, except that sizes No. 10 AWG and smaller shall be bare solid copper. Bonding conductors shall be stranded for final connection to motors, transformers, and vibrating equipment.
 - F. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.
 - G. Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.
 - H. Grounding System Resistance:
 - 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Engineer. Precipitation within the previous 48 hours does not constitute normally dry conditions.
 - 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
 - 3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.
 - I. Grounding Electrode System:
 - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 - 2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
 - 3. Metal Building or Structure Frame:
 - a. Provide connection to metal building or structure frame effectively grounded in accordance with NFPA 70 at nearest accessible location.
 - 4. Ground Rod Electrode(s):
 - a. Provide two electrodes unless otherwise indicated or required.
 - b. Space electrodes not less than 10 feet from each other and any other ground electrode.
 - c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
 - 5. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
 - J. Service-Supplied System Grounding:
 - 1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
 - 2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other

connections between neutral (grounded) conductors and ground on load side of service disconnect.

- K. Bonding and Equipment Grounding:
 - 1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 - 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
 - 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
 - 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
 - 5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
 - 6. Provide bonding for metal building frame where not used as a grounding electrode.
- L. Communications Systems Grounding and Bonding:
 - 1. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
 - a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
 - b. Raceway Size: 3/4 inch unless otherwise indicated or required.
 - c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
 - d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 - 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in addition to requirements of Section 26 0519:
 - 1. Use insulated copper conductors unless otherwise indicated.
- C. Connectors for Grounding and Bonding:
 - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 - 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 - 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
- D. Ground Bars:
 - 1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 - 2. Size: As indicated.
 - 3. Holes for Connections: As indicated or as required for connections to be made.
- E. Ground Rod Electrodes:
 - 1. Comply with NEMA GR 1.
 - 2. Material: Copper-bonded (copper-clad) steel.
 - 3. Size: 3/4 inch diameter by 12 foot length, unless otherwise indicated.
 - 4. Where rod lengths of greater than 10 feet are indicated or otherwise required, sectionalized ground rods may be used.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
- D. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 - 3. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 4. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- E. Identify grounding and bonding system components in accordance with Section 26 0553.
- F. Raceway
 - 1. Conduit Systems:
 - a. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
 - b. Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a equipment grounding conductor to the equipment ground bus.
 - 2. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders, and power and lighting branch circuits.
 - 3. Boxes, Cabinets, Enclosures, and Panelboards:
 - a. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
 - b. Provide lugs in each box and enclosure for equipment grounding conductor termination.
 - 4. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to the device box ground screw and a jumper to the branch circuit equipment grounding conductor.
 - 5. Ground lighting fixtures to the equipment grounding conductor of the wiring system. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.
- G. Telephone System:

1. Provide grounding means for the telephone system in accordance with Article 800-100 of the National Electrical Code, and the system manufacturer's recommendations.
 2. Main telephone service equipment grounding means shall include but not be limited to a No. 6 AWG, green, insulated, copper grounding conductor connected to the main electrical service equipment ground bus. Terminate this conductor at the telephone equipment location with an ILSCO NB-350-42-R16 grounding bus mounted on the plywood backboard.
 3. Telephone terminal boards and other remote telephone equipment grounding means shall include but not be limited to a minimum No. 6 AWG, green, insulated, copper conductor connected to the equipment ground bus in the low voltage panelboard serving the telephone equipment or branch circuits in the immediate vicinity. Terminate these conductors to an ILSCO NB-350-12-R16 grounding bus mounted on the plywood backboard.
 4. Route the telephone equipment grounding conductors in 3/4 inch conduit by the most direct means from the telephone equipment ground bus to the electrical equipment grounding system.
 5. Provide permanent, engraved labels at the telephone equipment ground busses identifying these as the equipment grounding means and identifying the location of connection of the grounding conductors to the electrical equipment grounding system.
- H. Ground resistance:
1. Grounding system resistance to ground shall not exceed 5 ohms. Make any modifications or additions to the grounding electrode system necessary for compliance. Final tests shall ensure that this requirement is met.
 2. Grounding system resistance shall comply with the electric utility company ground resistance requirements.

3.03 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS except Section 4.
- B. Tests and Inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
- C. Grounding system will be considered defective if it does not pass tests and inspections
- D. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 2. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohms.
- E. Perform tests under the supervision of the Master Electrician licensed in the jurisdiction who will certify the findings. The use of a NETA certified testing agency is acceptable
- F. Perform inspections and tests listed in NETA ATS, Section 7.13.
- G. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.
- H. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION

SECTION 26 0529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Comply with provision of Section 26 0500 Common Work Results for Electrical.
- B. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.
- C. Basic materials and methods, along with Division 01, General Requirements, that are applicable to all Division 26 sections

1.02 RELATED REQUIREMENTS

- A. Section 26 0534 - Raceways and Conduit Systems: Additional support and attachment requirements for conduits.
- B. Section 26 5100 - Interior Lighting: Additional support and attachment requirements for interior luminaires.
- C. Section 26 5600 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 3. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 4. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

- d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Thomas & Betts Corporation: www.tnb.com.
 - c. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Single Conduit up to 1 inch (27mm) trade size: 1/4 inch diameter.
 - c. Single Conduit larger than 1 inch (27mm) trade size: 3/8 inch diameter.
 - d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
 - e. Outlet Boxes: 1/4 inch diameter.
 - f. Luminaires: 1/4 inch diameter.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 4 inch high concrete pad constructed in accordance with Section 03 3000. Construct concrete bases

of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Conduit Support and Attachment: Also comply with Section 26 0534.
- I. Box Support and Attachment: Also comply with Section 26 0537.
- J. Interior Luminaire Support and Attachment: Also comply with Section 26 5100.
- K. Exterior Luminaire Support and Attachment: Also comply with Section 26 5600.
- L. Secure fasteners according to manufacturer's recommended torque settings.
- M. Remove temporary supports.
- N. For support of low voltage wiring not required to be in conduit, Contractor shall bundle cables together in a neat manner using approved nylon cable ties. Bundled cables shall be supported with "J" hooks on telephone type bridle rings, a minimum of six feet on centers.
 1. Use UL listed cable ties for plenum use in plenum areas.
 2. Maximum supported weight rating of "J" hooks shall not be exceeded.
 3. Identify differing types of cables and tag them with tape indicating service, i.e. telephone, nurse call and dictation.
 4. Identification tape shall be provided at minimum intervals of 25 feet on center and within each individual space.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 26 0533
RACEWAYS AND CONDUIT SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Comply with provision of Section 26 0500 Common Work Results for Electrical.
- B. Liquidtight flexible metal conduit (LFMC).
- C. Electrical metallic tubing (EMT).
- D. Rigid polyvinyl chloride (PVC) conduit.
- E. Conduit fittings.
- F. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 0500 - Common Work Results for Electrical.
- B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC) and armored cable (Type AC), including uses permitted.
- C. Section 26 0526 - Grounding and Bonding for Electrical Systems.
 - 1. Includes additional requirements for fittings for grounding and bonding.
- D. Section 26 0529 - Hangers and Supports for Electrical Systems.
- E. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.
- B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.
- C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); National Electrical Contractors Association; 2006.
- F. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; National Electrical Manufacturers Association; 2003.
- G. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- I. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- J. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
- K. UL 651 - Schedule 40 and 80 Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
- L. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- M. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.

2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
 4. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Sequencing:
1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
1. Exterior, Direct-Buried: Use rigid PVC conduit.
 2. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit or intermediate metal conduit (IMC) where emerging from underground.
- D. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).
- E. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).
- F. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
- G. Exposed, Interior, Not Subject to Physical Damage: Use electrical metallic tubing (EMT).
- H. Exposed, Exterior: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal conduit.
- I. Connections to Vibrating Equipment:
1. Dry Locations: Use flexible metal conduit.
 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
 3. Maximum Length: 6 feet unless otherwise indicated.
- J. Fished in Existing Walls, Where Necessary: Use flexible metal conduit.

2.02 CONDUIT REQUIREMENTS

- A. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- B. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
- C. Minimum Conduit Size, Unless Otherwise Indicated:
1. Branch Circuits: 3/4 inch (21 mm) trade size.
 2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
 3. Control Circuits: 3/4 inch trade size.
 4. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.
 5. Underground, Interior: 1 inch (27 mm) trade size.
 6. Underground, Exterior: 1 inch (27 mm) trade size.
 7. Communication: 1 inch.

- D. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

2.04 INTERMEDIATE METAL CONDUIT (IMC)

- A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

2.05 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
1. AFC Cable Systems, Inc: www.afcweb.com.
 2. Electri-Flex Company: www.electriflex.com.
 3. International Metal Hose: www.metalhose.com.
- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

2.07 ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

2.08 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.
- C. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- D. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- E. Conduit Routing:
1. When conduit destination is indicated and routing is not shown, determine exact routing required.
 2. Conceal all conduits unless specifically indicated to be exposed.
 3. Cut square, ream, remove burrs, and draw up tight. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
 4. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
 5. Arrange conduit to provide no more than 100 feet between pull points.
 6. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
 7. Group parallel conduits in the same area together on a common rack.
- F. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
 2. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 3. Use of wire for support of conduits is not permitted.
- G. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 3. Use suitable adapters where required to transition from one type of conduit to another.
 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
 7. Provide insulated bushing on both ends of empty conduits.
- H. Motors and Vibrating Equipment:
1. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.
- I. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
 5. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
- J. Underground Installation:
1. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 24 inches.
 2. No PVC shall emerge from the ground, concrete slab, or concrete encasement. PVC shall convert to galvanized rigid steel conduit at least 6 inches before exiting concrete slab or concrete encasement. Schedule 80 PVC shall be used if shown on drawing.
 3. Provide underground warning tape in accordance with Section 26 0553 along entire conduit length for service entrance where not concrete-encased.
- K. Wet or Damp Locations:
1. Unless otherwise shown, use conduits of rigid steel or IMC.
 2. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.
 3. For damp or wet locations, indoor or outdoor locations where NEMA 4 or 4X enclosures are used, secure conduits to boxes and cabinets with Myers Scru-Tite hub.
- L. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

- M. Provide grounding and bonding in accordance with Section 26 0526.
- N. Identify conduits in accordance with Section 26 0553.
 - 1. Where feeder or branch conduits enter pull boxes or junction boxes, clearly mark on conduit on the entering and leaving side of each box the panel name and circuit number(s) contained within the conduit using a permanent black marker.

3.02 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.03 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 26 0537
PULL AND JUNCTION BOXES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

1.02 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0534 - Raceways and Conduit Systems:
 - 1. Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 2726 - Wiring Devices:
 - 1. Floor box service fittings.
 - 2. Poke-through assemblies.
 - 3. Access floor boxes.
 - 4. Additional requirements for locating boxes for wiring devices.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- B. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
 - 3. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 BOXES

- A. General Requirements:
 - 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 - 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 - 3. Provide products listed, classified, and labeled as suitable for the purpose intended.

4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use raised covers suitable for the type of wall construction and device configuration where required.
 3. Use shallow boxes where required by the type of wall construction.
 4. Do not use "through-wall" boxes designed for access from both sides of wall.
 5. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 6. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 7. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
 8. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
 - b. Communications Systems Outlets: Comply with Section 27 1005.
 - c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
- C. Floor Boxes:
1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 2726; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
 2. Use cast iron floor boxes within slab on grade.
 3. Use sheet-steel or cast iron floor boxes within slab above grade.
 4. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
 5. Manufacturer: Same as manufacturer of floor box service fittings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- E. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- F. Box Locations:
 1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 3100 as required where approved by the Architect.
 2. Unless dimensioned, box locations indicated are approximate.
 3. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.

4. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
- G. Box Supports:
1. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
 2. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
- H. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.
- I. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- J. Close unused box openings.
- K. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- L. Provide grounding and bonding in accordance with Section 26 0526.
- M. Identify boxes in accordance with Section 26 0553.
- N. Color code pull and junction boxes and identify feeders and circuits entering pull and junction boxes as called for in Section 26 05 53.

3.02 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.03 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 0553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.

1.02 RELATED REQUIREMENTS

- A. Section 26 0500 - Common Work Results for Electrical
- B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- C. Section 26 2726 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.

1.03 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Comply with ANSI A13.1 and IEEE C2.
- C. Comply with ANSI Z535.4 for safety signs and labels.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

- A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
- B. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Panelboards:
 - 1) Name.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - b. Time Switches:
 - 1) Identify load(s) served and associated circuits controlled. Include location.
 - c. Enclosed Contactors:
 - 1) Identify voltage and phase.
 - 2) Identify load(s) and associated circuits controlled. Include location.
 - 2. Service Equipment:
 - a. Use identification nameplate to identify each service disconnecting means.
- C. Identification for Conductors and Cables:
 - 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.
 - 2. The color code as outlined below shall be used. In addition, on each panelboard, pullbox, control cabinet, or other electrical enclosure that contains circuits from more than one system, provide an engraved phenolic plate and identify the circuit conductors with the following color code:
 - a. 208Y/120, Phase A, black, Phase B, red, Phase C, blue, grounded conductor, white, equipment grounding conductor, green, isolated equipment grounding conductor, green/yellow stripe.

3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
 - a. At each source and load connection.
 - b. Within boxes when more than one circuit is present.
 - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
 4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
- D. Identification for Boxes:
1. Identify feeder j-boxes and pull boxes with designation of panelboard/switchboard source as "FROM" and load served as "TO" with permanent labels.
 2. Identify pull and junction boxes with the designation of panelboard and the circuit number of each circuit contained therein, with permanent marker. Clearly mark information on or in the box, not on the cover, so that the information is easily identifiable.
- E. Identification for Devices:
1. Wiring Device and Wallplate Finishes: Comply with Section 26 2726.
 2. Use identification label to identify serving branch circuit for all receptacles.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
1. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
 2. Plastic Nameplates: Two-layer or three-layer laminated electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.

2.03 WIRE AND CABLE MARKERS

- A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- B. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- C. Minimum Text Height: 1/8 inch.
- D. Color: Black text on white background unless otherwise indicated.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
1. Surface-Mounted Equipment: Enclosure front.
 2. Flush-Mounted Equipment: Inside of equipment door.
 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 4. Interior Components: Legible from the point of access.
 5. Conduits: Legible from the floor.
 6. Boxes: Outside face of cover.
 7. Conductors and Cables: Legible from the point of access.
 8. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.

- D. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- E. Mark all handwritten text, where permitted, to be neat and legible.

3.02 FIELD QUALITY CONTROL

- A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

SECTION 26 0560
LOW VOLTAGE SYSTEM ROUGH-IN REQUIREMENTS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Comply with the provisions of Section 26 0500.
- B. Provide rough-in including backboxes, backboards, conduit, conduits stubbed up, etc. as required for the following systems being supplied by the Owner or others:
- C. Telephone System.
- D. Information/Data Systems.

1.02 RELATED WORK

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems
- B. Section 26 0529 - Hangers and Supports for Electrical Systems
- C. Section 26 0533 - Raceways and Conduit Systems
- D. Section 26 0537 - Pull and Junction Boxes
- E. Section 26 0535 - Outlet Boxes
- F. Section 26 2727 - Wiring Device Plates

PART 2 - PRODUCTS

2.01 EQUIPMENT AND MATERIALS

- A. Interior systems components provided by Owner/Others will include system equipment, special outlet box receptacles, power unit cabinets, special outlet boxes, and cable.
- B. Provide 4'x8'x3/4" plywood backboards, painted with two coats of flat black fire retardant, paint where shown on drawings.
- C. Install outlet boxes with conduit stubbed up above nearest accessible ceiling or to cable tray. Where nearest accessible ceiling does not provide direct access to cable tray or nearest telecom closet, provide associated quantity and size of sleeves in walls and cable supports suitable for cable as required to gain access to cable tray or nearest telecom closet.
- D. Install underground service entrance conduit for telephone/CATV service to the main equipment room as shown on drawings.

PART 3 - EXECUTION

3.01 INSTALLATION REQUIREMENTS

- A. Schedule systems deliveries and installation with Owner and vendor.
- B. Receive, inventory, store, and protect equipment and cable furnished by Owner.
- C. Install special outlet boxes provided by Owner for dictation, computer, and CATV systems as directed by Owner and vendors.
- D. The Contractor shall have the local telephone utility, the systems vendors, and the Owner review the drawings to verify that provisions on the drawings will accommodate the installation of the proposed services and systems. Report discrepancies promptly to Architect.
- E. Schedule systems start-up, inspections, and certifications with owner and vendors.
- F. Service Entrance Requirements:
 - 1. Provide trenching and backfilling required for installation of service entrance conduits
 - 2. Install a pull wire or rope for installation of service cables.
 - 3. Coordinate service entrance with local service provider.
- G. Install a separate conduit stubbed up and bushed above accessible ceilings, and bushed into the corridor ceiling space or and bushed 6 inches above the systems cable tray to serve each

device outlet. Size conduit in accordance with the wiring schematic furnished by the Owner. Install a minimum size of 3/4 inch conduit, terminated with insulated bushing.

- H. Cable concealed in walls or above inaccessible ceilings shall be installed in conduit.
- I. Where open cable is run above dropped ceilings and penetrates a smoke or fire rated wall, furnish and install an empty metal conduit sleeve, extending at least 6" on both sides of partition with bushing on both ends. For sleeve or cable penetrations through fire or smoke rated walls or partitions, provide a U.L. 1479 listed "Through Penetration Firestop" system for each sleeve or cable penetration.

END OF SECTION

SECTION 26 0923
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0537 - Pull and Junction Boxes.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 2726 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, and fan speed controllers.
- E. Section 26 5100 - Interior Lighting.
- F. Section 26 5113 - Luminaires, Ballasts, and Drivers - Lutron.
- G. Section 26 5600 - Exterior Lighting.

1.02 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
 - 3. Notify Engineer of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.04 SUBMITTALS

- A. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
- B. Field Quality Control Reports.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

2.02 OCCUPANCY SENSORS

- A. All Occupancy Sensors:
 - 1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
 - 2. Sensor Technology:

- a. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
3. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
4. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 0537 as required for installation of lighting control devices provided under this section.
- C. Install lighting control devices in accordance with manufacturer's instructions.
- D. Occupancy Sensor Locations:
 1. Location Adjustments: Within the design intent, reasonably minor adjustments to locations may be made in order to optimize coverage and avoid conflicts or problems affecting coverage.
 2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.

3.02 FIELD QUALITY CONTROL

- A. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.

3.03 CLOSEOUT ACTIVITIES

- A. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

END OF SECTION

SECTION 26 2416
PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 26 4300 - Surge Protective Devices.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- B. NECA 407 - Standard for Installing and Maintaining Panelboards; National Electrical Contractors Association; 2009.
- C. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association; 2011.
- D. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association; 2013 (ANSI/NEMA PB 1.1).
- E. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).
- F. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 67 - Panelboards; Current Edition, Including All Revisions.
- H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
 - 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.

1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.07 WARRANTY

- A. Warrants equipment to be free from defects in materials and workmanship for 1 year from the Manufacturer date of acceptance by the owner or 18 months from date of delivery, whichever occurs first.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Siemens Industry, Inc: www.usa.siemens.com.
- B. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.
- C. General Electric Company: www.geindustrial.com.
- D. Schneider Electric; Square D Products: www.schneider-electric.us.

2.02 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Short Circuit Current Rating:
 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- C. Provide thermal magnetic circuit breakers which are fully rated and temperature rated for a 40 degrees C ambient. Breakers shall be quick-make, quick-break type with trip indication shown by handle position other than ON or OFF and with a common trip on all multi-pole breakers.
- D. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
 3. Material: Hard-drawn copper, 98 percent conductivity.
- E. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - b. Provide removable end walls for NEMA Type 1 enclosures.
 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
 - c. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 4. Directory Card: Inside panelboard door, mounted in transparent card holder.

2.03 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Circuit breaker type power distribution panelboards for 120/208 volts, 3-phase, 4-wire service shall be equipped with circuit breakers having AIC rating as indicated on the drawings. Where AIC ratings are not shown on drawings obtain the rating requirements from the Engineer. Panelboards shall be equal to:
 - 1. Square D, "I-Line" series distribution type
 - 2. General Electric, "Spectra" series distribution type
 - 3. Eaton/Cutler-Hammer, "PRL4B" distribution type
 - 4. Siemens, type P4 or P5, depending upon panelboard ampacity
- C. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
 - 2. Main and Neutral Lug Type: Mechanical.
- D. Bussing:
 - 1. Power distribution panelboards shall be furnished with full-height bussing.
 - 2. Phase and Neutral Bus Material: Copper.
 - 3. Ground Bus Material: Copper.
- E. Circuit Breakers:
 - 1. Provide bolt-on type.
 - 2. Provide thermal magnetic circuit breakers unless otherwise indicated.
 - 3. Provide electronic trip circuit breakers where indicated.
- F. Enclosures:
 - 1. Provide surface-mounted enclosures unless otherwise indicated.
 - 2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 - 3. Provide clear plastic circuit directory holder mounted on inside of door.

2.04 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Circuit breaker type lighting and appliance panelboards for 120/208 volts, 3-phase, 4-wire service shall be equipped with circuit breakers having AIC ratings as indicated on the drawings, but not less than 10,000 AIC. Panelboards shall be equal to:
 - 1. Square D, "N" series
 - 2. General Electric, type AQ
 - 3. Eaton/Cutler-Hammer, type PRL1A
 - 4. Siemens, type P1
- C. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
 - 2. Main and Neutral Lug Type: Mechanical.
- D. Bussing:
 - 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
 - 2. Phase and Neutral Bus Material: Copper.
 - 3. Ground Bus Material: Copper.

- E. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
- F. Enclosures:
 - 1. Provide surface-mounted or flush-mounted enclosures as indicated.
 - 2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 - 3. Provide clear plastic circuit directory holder mounted on inside of door.

2.05 OVERCURRENT PROTECTIVE DEVICES

- A. Molded Case Circuit Breakers:
 - 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 - 2. Circuit breakers shall be bolt-on type. Plug-in type is not acceptable.
 - 3. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
 - 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - b. Provide interchangeable trip units where indicated.
 - 5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - 6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
 - 7. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.
 - 8. Do not use handle ties in lieu of multi-pole circuit breakers.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.
- C. Directory-card information shall be typewritten in capital letters to indicate outlets controlled and final room numbers served by each circuit and shall be mounted in holders behind protective covering. Space names and numbers shall match the graphics installed if different from the space names and numbers on the drawings
- D. Provide grounding and bonding in accordance with Section 26 0526.
- E. Install all field-installed branch devices, components, and accessories.
- F. Install branch circuits using a separate neutral for each circuit. Multewire circuit are not acceptable.
- G. Provide filler plates to cover unused spaces in panelboards.

3.02 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.

3.03 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 2726
WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall switches.
- B. Receptacles.
- C. Wall plates.
- D. Floor box service fittings.
- E. Poke-through assemblies.

1.02 RELATED REQUIREMENTS

- A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables : Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors .
- B. Section 26 0500 - Common Work Results for Electrical.
- C. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- D. Section 26 0538 - Outlet Boxes
- E. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 26 0923 - Lighting Control Devices: Devices for automatic control of lighting, including occupancy sensors, in-wall time switches, and in-wall interval timers.
- G. Section 26 5100 - Interior Lighting.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- B. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
- D. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- E. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- F. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
 - 3. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
 - 4. Notify Engineer of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.
- B. Sequencing:
 - 1. Do not install wiring devices until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.
- C. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hubbell Incorporated: www.hubbell-wiring.com.
- B. Leviton Manufacturing Company, Inc: www.leviton.com.
- C. Lutron Electronics Company, Inc: www.lutron.com.
- D. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us

2.02 WIRING DEVICE APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. Provide weather resistant GFI receptacles with specified weatherproof covers for all receptacles installed outdoors or in damp or wet locations.
- C. Provide GFI protection for all receptacles installed within 6 feet of sinks.
- D. For flush floor service fittings, use tile rings for installations in tile floors.
- E. For flush floor service fittings, use carpet flanges for installations in carpeted floors.

2.03 ALL WIRING DEVICES

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- B. Finishes:
 - 1. All Wiring Devices: White with white nylon wall plate unless otherwise indicated.
 - 2. Wiring Devices Installed in Wet or Damp Locations: White with specified weatherproof cover unless otherwise indicated.
 - 3. Flush Floor Box Service Fittings: Gray wiring devices with aluminum cover and ring/flange.
 - 4. Flush Poke-Through Service Fittings: Gray wiring devices with aluminum cover and aluminum flange.

2.04 WALL SWITCHES

- A. All Wall Switches: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
 - 2. Shall be single unit toggle, butt contact, heavy duty general-purpose use with an integral self grounding mounting strap with break-off plaster ears and provisions for back wiring with separate metal wiring clamps and side wiring with captively held binding screws.
- B. Standard Wall Switches: Commercial specification grade, 20 A, 120 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.05 RECEPTACLES

- A. All Receptacles: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.

2. NEMA configurations specified are according to NEMA WD 6.
 3. Weather resistant Receptacles: Shall consist of a duplex receptacle, mounted in box with a gasketed, weatherproof, cast metal cover plate and cap over each receptacle opening. The cap shall be permanently attached to the cover plate by a spring-hinged flap. The weatherproof integrity shall not be affected when heavy duty specification or hospital grade attachment plug caps are inserted. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner.
- B. Convenience Receptacles:
1. Standard Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
 2. Weather Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, , listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
 3. Tamper Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, , listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
 - a. Hubbell; HBL8300SGA.
- C. GFI Receptacles:
1. Standard GFI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style. Suitable for mounting in a standard outlet box, with end-of-life indication and provisions to isolate the face due to improper wiring.
 2. Weather Resistant GFI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

2.06 WALL PLATES

- A. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.
- B. Weather-resistant Covers for Wet Locations: NEMA 250, complying with Type 3R, gasketed, thermoplastic, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected.

2.07 FLOOR BOX SERVICE FITTINGS

- A. Manufacturers:
1. Hubbell Incorporated: www.hubbell-wiring.com.
 2. Thomas & Betts Corporation: www.tnb.com.
 3. Wiremold, a brand of Legrand North America, Inc: www.legrand.us
- B. Description: Service fittings compatible with floor boxes provided under Section 26 0537 with all components, adapters, and trims required for complete installation.
- C. Flush Floor Service Fittings:
1. Single Service Flush Convenience Receptacles:
 - a. Cover: Rectangular.
 - b. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
 2. Single Service Flush Communications Outlets:
 - a. Cover: Rectangular.
 3. Single Service Flush Furniture Feed:
 - a. Cover: Rectangular.
 - b. Configuration: One 2-1/8 inch by 3/4 inch combination threaded opening(s).
 4. Dual Service Flush Combination Outlets:
 - a. Cover: Rectangular.
 - b. Configuration:

- 1) Power: One standard convenience duplex receptacle(s) with duplex flap opening(s).
5. Dual Service Flush Furniture Feed:
 - a. Cover: Rectangular.
 - b. Configuration:
 - 1) Power: One 2-1/8 inch by 3/4 inch combination threaded opening(s).
 - 2) Communications: One 2-1/8 inch by 1 inch combination threaded opening(s).
6. Accessories:
 - a. Tile Rings: Finish to match covers; configuration as required to accommodate specified covers.
 - b. Carpet Flanges: Finish to match covers; configuration as required to accommodate specified covers.

2.08 POKE-THROUGH ASSEMBLIES

- A. Manufacturers:
 1. Hubbell Incorporated: www.hubbell-wiring.com.
 2. Thomas & Betts Corporation: www.tnb.com.
 3. Wiremold, a brand of Legrand North America, Inc: www.legrand.us
- B. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.
- C. Flush Floor Service Fittings:
 1. Single Service Flush Convenience Receptacles:
 - a. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
 2. Single Service Flush Communications Outlets:
 3. Single Service Flush Furniture Feed:
 - a. Configuration: One 2 inch by 1-1/4 inch combination threaded opening(s).
 4. Dual Service Flush Combination Outlets:
 - a. Cover: Hinged door(s).
 - b. Configuration:
 - 1) Power: One standard convenience duplex receptacle(s).
 5. Dual Service Flush Furniture Feed:
 - a. Configuration:
 - 1) Power: One 3/4 inch threaded opening(s).
 - 2) Communications: Two 1/2 inch threaded opening(s).
 6. Accessories:
 - a. Closure Plugs: Size and fire rating as required to seal unused core hole and maintain fire rating of floor.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 0537 as required for installation of wiring devices provided under this section. Mounting height of wall-mounted outlet and switch boxes, measured between the bottom of the box and the finished floor, shall be in accordance with ICC/ANSI A117.1 and as follows:
 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switches: 48 inches above finished floor.
 - b. Receptacles: 18 inches above finished floor or 6 inches above counter.

2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 3. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Engineer to obtain direction prior to proceeding with work.
- C. Install weather resistant receptacles in damp and wet locations.
 - D. Provide GFI receptacles with integral GFI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
 - E. Install wall switches with OFF position down.
 - F. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
 - G. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
 - H. Identify wiring devices in accordance with Section 26 0553.

3.02 FIELD QUALITY CONTROL

- A. Perform field inspection, testing, and adjusting in accordance with Section 01 4000.
- B. Test each receptacle to verify operation and proper polarity.
- C. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- D. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.03 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

SECTION 26 4300
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. All SPDs must comply with UL 1149 Third Addition and service entrance SPDs must also comply with UL 96A.
- B. Surge protective devices for service entrance locations.
- C. Surge protective devices for distribution locations.
- D. Surge protective devices for branch panelboard locations.

1.02 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 26 0500 - Common Work Results for Electrical.
- C. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- D. Section 26 2300 - Low Voltage Switchgear.
- E. Section 26 2726 - Wiring Devices: Receptacles with integral surge protection.
- F. Section 26 2416 - Panelboards.

1.03 ABBREVIATIONS AND ACRONYMS

- A. I nominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SPD: Surge protective device.
- H. VPR: Voltage protection rating.
- I. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.
- J. SPD: Surge Protective Device.

1.04 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NEMA Standard LS-1 - Low-Voltage Surge Protective Devices.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Engineer of any conflicts or deviations from the contract documents to obtain direction prior to ordering equipment.

1.06 SUBMITTALS

- A. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current

rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.

1. SPDs with EMI/RFI filter: Include noise attenuation performance.
- B. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
 1. UL 96A listing file information for all service entrance SPDs
 2. UL 1449.
 3. UL 1283 (for Type 2 SPDs).
- C. Provide verification that the SPD complies with the required ANSI/UL 1449
 1. Third Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, so long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR) and Nominal Discharge Current (In).
- D. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.07 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

1.08 WARRANTY

- A. Manufacturer's Warranty: Provide minimum ten year warranty from date of Substantial Completion covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.
- B. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design: PQ Protection.

2.02 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

- A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.
- B. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) or other approved methods as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize any components that may crowbar the system voltage leading to system upset or create any environmental hazards
- C. SPDs with the following features and accessories:
 1. Integral disconnect switch.
 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 3. Indicator light display for protection status.
 4. Form-C contacts rated at 5 A and 250-V ac one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 5. Surge counter.
- D. Protected Modes:

1. Wye Systems: L-N, L-G, N-G, L-L.
 2. Delta Systems: L-G, L-L.
 3. Single Split Phase Systems: L-N, L-G, N-G, L-L.
 4. High Leg Delta Systems: L-N, L-G, N-G, L-L.
- E. UL 1449 Voltage Protection Ratings (VPRs):
1. 208Y/120V System Voltage: Not more than 700 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
- F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.
- G. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- H. Nominal Discharge Current (In) - All SPDs applied to the distribution system shall have a 20 kA In rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an In less than 20kA shall be rejected.
- I. SCCR: Equal or exceed 100 kA.
- J. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.
- K. System Application:
1. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.
 - a. Category C shall be used for the following:
 - 1) Service entrance, switchgear, switchboards, and motor control centers (MCC)
 - b. Category B shall be used for the following:
 - 1) Distribution panelboards, emergency system panelboards, and medical equipment panelboards
 - c. Category A shall be used for the following:
 - 1) Lighting panelboards, major medical equipment, and busways
 2. Surge Current Capacity - The minimum surge current capacity the device is capable of withstanding shall be:
 - a. Category C: 250 kA per phase and 125 kA per mode
 - b. Category B: 160 kA per phase and 80 kA per mode
 - c. Category A: 120 kA per phase and 60 kA per mode
 3. SPD Type - All SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.03 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

- A. Unless otherwise indicated, provide field-installed, externally mounted or factory-installed, internally mounted SPDs.
- B. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
- C. An external mounted SPD shall have a properly sized circuit breaker mounted as in paragraph 2.03(B) and be connected using a low impedance, flexible, multi-conductor cable supplied by the SPD manufacturer and designed for use with SPDs. The length shall be as short as possible and shall not exceed 36 inches without approval from the Engineer.

- D. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.
- E. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.
- F. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.
- G. Repetitive Surge Current Capacity: Not less than 5,000 impulses.
- H. UL 1449 Nominal Discharge Current (I-n): 20 kA.
- I. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
- J. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
 - 1. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.
- K. All monitoring and diagnostic features shall be visible from the front of the equipment.
- L. Diagnostics:
 - 1. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.
 - 2. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
 - 3. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
 - 4. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.
- M. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.04 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

- A. Unless otherwise indicated, provide field-installed, externally mounted or factory-installed, internally mounted SPDs.
- B. List and label as complying with UL 1449, Type 1 or Type 2.
- C. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.
- D. Surge Current Rating: Not less than 60 kA per mode/120 kA per phase.
- E. UL 1449 Nominal Discharge Current (I-n): 20 kA.
- F. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
- G. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
 - 1. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.
- H. Diagnostics:
 - 1. Protection Status Monitoring: Provide indicator lights to report the protection status.
 - 2. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
 - 3. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.
 - 4. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.

- I. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.
- C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of the drawings and manufacturer's instructions.
- D. Verify system grounding and bonding is in accordance with Section 26 0526, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1.
- B. Install SPD in accordance with manufacturer's instructions.
- C. Use crimped connectors and splices only. Wire nuts are unacceptable.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Unless indicated otherwise, connect service entrance surge protective device on load side of service disconnect main overcurrent device.
- F. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.
- G. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.
- H. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 0526 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.
- I. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

3.03 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS Section 7.19.1.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
 - 2. Inspect anchorage, alignment, grounding, and clearances.
 - 3. Verify that disconnecting means and feeder size and maximum length to TVSS corresponds to approved shop drawings.
 - 4. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
 - 5. Vacuum-clean enclosure interior. Clean enclosure exterior.
 - 6. Verify the correct operation of all sensing devices, alarms, and indicating devices.

- D. An SPD will be considered defective if it does not pass tests and inspections.
- E. After completion of acceptance checks and tests, the Contractor shall show by demonstration in service that the SPD are in good operating condition and properly performing the intended function.

3.04 CLEANING

- A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

**SECTION 26 5100
INTERIOR LIGHTING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior luminaires.
- B. Emergency lighting units.
- C. Exit signs.
- D. Ballasts and drivers.
- E. Fluorescent emergency power supply units.
- F. Lamps.
- G. Luminaire accessories.

1.02 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provide labor, material, equipment and fixtures for interior lighting including necessary hangers and lamps. Fixtures shall be completely wired, controlled and securely attached to supports.
- C. Fixtures and associated components shall be new, of good quality and shall arrive on the jobsite in original packaging.
- D. Fixtures shall be listed by a Nationally Recognized Testing Laboratory, and shall meet required local, state and national building codes and regulations. Luminaires installed in exterior locations, unprotected from precipitation, shall be listed for wet location use. Luminaires installed in protected exterior areas or in interior areas subject to extreme humidity shall be listed for damp location use.
- E. Section 26 0500 - Common Work Results for Electrical.
- F. Section 26 0526 - Grounding and Bonding.
- G. Section 26 0537 - Pull and Junction Boxes.
- H. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- I. Section 26 0923 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.
- J. Section 26 2726 - Wiring Devices: Manual wall switches and wall dimmers.

1.03 REFERENCE STANDARDS

- A. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; Illuminating Engineering Society; 2008.
- B. IES LM-80 - Approved Method: Measuring Lumen Maintenance of LED Light Sources; Illuminating Engineering Society; 2008.
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NFPA 101 - Life Safety Code; National Fire Protection Association; 2012.
- E. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
- F. UL 935 - Fluorescent-Lamp Ballasts; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
 - 2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
 - 3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.

1.05 SUBMITTALS

- A. Partial submittals will not be accepted. Resubmittals, where required, may be partial as determined by the submittal review.
- B. Fixture submittals shall be arranged numerically as specified.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.

2.02 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- D. Fixtures shall be free of light leaks and shall be designed to provide sufficient ventilation of lamps and ballasts including vent holes where required. Exterior fixtures shall have wire mesh corrosion resistant screens in the vent holes.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Lenses:
 - 1. Lenses, louvers and other light diffusing components shall be contained in frames. Components shall be removable but positively held within the frames so that hinging or other motion of the frame will not cause the diffusing component to drop out. This safety

device shall be detachable if necessary and shall not interfere with the fixture performance, maintenance, or the seating of any fixture element, and shall not be visible during normal fixture operation.

- G. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
- H. Fluorescent Luminaires:
 - 1. Provide ballast disconnecting means complying with NFPA 70 where required.
- I. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.03 EMERGENCY LIGHTING UNITS

- A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- C. Battery:
 - 1. Sealed maintenance-free lead calcium unless otherwise indicated.
- D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
- E. Provide low-voltage disconnect to prevent battery damage from deep discharge.

2.04 EXIT SIGNS

- A. Description: Exit signs and similar signs for special purpose applications such as area of refuge/rescue assistance.
- B. All Exit Signs: Internally illuminated with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
 - 1. Number of Faces: Single or double as indicated or as required for the installed location.
 - 2. Directional Arrows: As indicated or as required for the installed location.
- C. Self-Powered Exit Signs:
 - 1. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
 - 2. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
 - 3. Provide low-voltage disconnect to prevent battery damage from deep discharge.

2.05 BALLASTS AND DRIVERS

- A. All Ballasts:
 - 1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
 - 2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
- B. Fluorescent Ballasts:
 - 1. All Fluorescent Ballasts: Unless otherwise indicated, provide high frequency electronic ballasts complying with ANSI C82.11 and listed and labeled as complying with UL 935.
 - a. Total Harmonic Distortion: Not greater than 10 percent.

- b. Power Factor: Not less than 0.95.
 - c. Ballast Factor: Normal ballast factor between 0.85 and 1.15, unless otherwise indicated.
- C. Dimmable LED Drivers:
- 1. Control Compatibility: Fully compatible with the dimming controls to be installed.

2.06 LAMPS

- A. Lamps - General Requirements:
- 1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
 - 2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
 - 3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
 - 4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Engineer to be inconsistent in perceived color temperature.
- B. Compact Fluorescent Lamps: Wattage and bulb type as indicated, with base type as required for luminaire.
- C. Linear Fluorescent Lamps: Wattage and bulb type as indicated, with base type as required for luminaire.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 0537 as required for installation of luminaires provided under this section.
- B. Install products according to manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).
- D. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- E. Emergency Lighting Units:
- 1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
- F. Exit Signs:
- 1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
- G. Fluorescent Emergency Power Supply Units:
- 1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal ballast(s) in luminaire. Bypass local switches, contactors, or other lighting controls.

3.02 FIELD QUALITY CONTROL

- A. Operate each luminaire after installation and connection to verify proper operation.
- B. Test self-powered exit signs, emergency lighting units, and fluorescent emergency power supply units to verify proper operation upon loss of normal power supply.
- C. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Engineer.

3.03 ADJUSTING

- A. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Engineer or authority having jurisdiction.

3.04 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.05 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 26 5600
EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Exterior luminaires.
- B. Ballasts.
- C. Lamps.

1.02 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0537 - Boxes.
- C. Section 26 0923 - Lighting Control Devices: Automatic controls for lighting including outdoor motion sensors, time switches, and outdoor photo controls.
- D. Section 26 5013 - Luminaire Schedule.
- E. Section 26 5100 - Interior Lighting.

1.03 REFERENCE STANDARDS

- A. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; Illuminating Engineering Society; 2008.
- B. IES LM-80 - Approved Method: Measuring Lumen Maintenance of LED Light Sources; Illuminating Engineering Society; 2008.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- D. NECA/IESNA 501 - Recommended Practice for Installing Exterior Lighting Systems; 2006.
- E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- G. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
 - 2. Lamps: Include rated life and initial and mean lumen output.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.

2.02 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.

2.03 BALLASTS

- A. All Ballasts:
 - 1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
 - 2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

2.04 LAMPS

- A. Lamps - General Requirements:
 - 1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
 - 2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
 - 3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
 - 4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Engineer to be inconsistent in perceived color temperature.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 0537 as required for installation of luminaires provided under this section.
- B. Install products according to manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship) and NECA/IESNA 501 (exterior lighting).
- D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- E. Install accessories furnished with each luminaire.

- F. Bond products and metal accessories to branch circuit equipment grounding conductor.
- G. Install lamps in each luminaire.

3.03 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.

3.04 CLEANING

- A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

END OF SECTION

**SECTION 28 3100
FIRE DETECTION AND ALARM**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Basic materials and methods, along with Division 01, General Requirements, that are applicable to all Division 26 sections.
- B. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 specification Sections apply to all Division 26 sections.
- C. Furnish and install electrical systems, materials, equipment, and accessories in accordance with this specifications and drawings.

1.02 RELATED REQUIREMENTS

- A. Section 26 0500 - Common work results for Electrical.
- B. Division 23 - Mechanical System Drawings.

1.03 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. NFPA 72 - National Fire Alarm and Signaling Code; 2013.
- D. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems; 2012.
- E. NFPA 101 - Life Safety Code; 2012.
- F. UL 268 - Smoke Detectors for Fire Alarm Systems; 2009.

1.04 SUBMITTALS

- A. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
 - 1. Copy (if any) of list of data required by authority having jurisdiction.
 - 2. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
 - 3. System zone boundaries and interfaces to fire safety systems.
 - 4. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
 - 5. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
 - 6. List of all devices on each signaling line circuit, with spare capacity indicated.
 - 7. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
 - 8. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
 - 9. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
 - 10. Certification by the manufacturer of the control unit that the system design complies with the contract documents.
 - 11. Certification by Contractor that the system design complies with the contract documents.
- B. Evidence of installer qualifications.
- C. Inspection and Test Reports:
 - 1. Submit documentation of satisfactory inspections and tests.

2. Submit NFPA 72 "Inspection and Test Form," filled out.
- D. Operating and Maintenance Data: _____; have one set available during closeout demonstration:
1. Complete set of specified design documents, as approved by authority having jurisdiction.
 2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
 3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
 4. List of recommended spare parts, tools, and instruments for testing.
 5. Replacement parts list with current prices, and source of supply.
 6. Detailed troubleshooting guide and large scale input/output matrix.
 7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
 8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
- E. Project Record Documents: _____:
1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
 3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
- F. Closeout Documents:
1. Certification by manufacturer that the system has been installed in compliance with his installation requirements, is complete, and is in satisfactory operating condition.
 2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
 3. Certificate of Occupancy.
 4. Maintenance contract.
- G. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
1. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data .
 2. Furnish the following:
 - a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
 - b. One copy, on CD-ROM, of all software not resident in read-only-memory.

1.05 SYSTEM DESCRIPTION

- A. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with the required and advisory provisions of NFPA 72, ISO 7240-16, IEC 60268-16, except as modified herein. The system layout on the drawings show the intent of coverage and are shown in suggested locations. Submit shop plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, wire counts, circuit identification in each conduit, and circuit layouts for all floors. Drawings shall comply with the requirements of NFPA 170. Final quantity, system layout, and coordination are the responsibility of the Contractor. A single fire alarm control panel is indicated with terminal cabinets at each floor, at each riser location.

1.06 SYSTEM OPERATION

- A. Initiate an alarm condition on the fire alarm system when one or more of the following devices or inputs are activated:
 - 1. Manual pull station
 - 2. Ceiling mounted smoke and heat detectors
 - 3. Duct mounted smoke detectors in the supply and return ducts of air handling units
 - 4. Duct mounted smoke detectors in the supply and return ducts of air handling units and at each damper
 - 5. Sprinkler system water flow switch
- B. Immediately perform the following alarm sequence when an alarm condition is activated on the system:
 - 1. Annunciate on the fire alarm system identifying the floor level, smoke compartment, room number and specific device(s) in alarm. (The room number used for identification shall be the room number assigned by the Owner and not necessarily the room number indicated on the floor plans. Coordinate the device description with the Owner.)
 - 2. Initiate a general fire alarm activating all audio/visual appliances.
 - 3. Close doors throughout the facility held open by electric door holders and deactivate all smoke barrier power operated doors.
 - 4. Unlock all egress doors that are electrically locked via a security or other system.
- C. Interface fire alarm system with the HVAC system such that when any device except a manual pull station activates an alarm condition, the following occurs in addition to the actions listed above:
 - 1. Shut down supply and return fans serving the affected smoke compartment.
 - 2. Close smoke dampers in the affected air handling systems.
 - 3. Initiate smoke control sequence in accordance with Division 23.
 - 4. Initiate stair pressurization sequence.
 - 5. Shutdown systems 2000 cfm and less that serve egress corridors upon alarm in the respective smoke compartment.
- D. Provide an elevator lobby smoke detector zone. When one or more detectors sense smoke, send a signal to the FACP to perform the following functions:
 - 1. Initiate a general fire alarm and perform all other functions outlined above for ceiling mounted smoke detectors.
 - 2. Flash a lighted sign in the associated elevator lobby that reads "DO NOT USE ELEVATOR". (Provide this sign under Division 26).
 - 3. Flash a lighted sign in the associated elevator lobby that reads "DO NOT USE ELEVATOR". (This illuminated sign furnished by other divisions and connected under Division 26).
 - 4. Initiate elevator recall sequence to automatically return elevators to a designated floor, where doors open and remain open until a fireman captures the elevator with a key in the elevator cab. Refer to Division 14 for designated return levels.
 - 5. Upon activation of lobby detectors on the designated floor, initiate the elevator recall to automatically return the elevators to an alternate floor (specified in Division 14) other than the designated floor, where the doors open and remain open until the fireman captures the elevator with a key in the elevator cab. Verify the location of the alternate floor prior to programming.
 - 6. Start elevator shaft pressurization fans (if installed).
- E. If hoist way is sprinklered, provide a separate elevator hoist way heat detector zone.
 - 1. Install a 180 degree heat detector placed adjacent to and within 12 inches of each sprinkler head in the elevator shaft. Where sprinkler heads are installed in the bottom of the hoist way, install heat detectors 26 inches or more above the elevator pit floor.

2. Upon activation of a heat detector in this zone, initiate the same functions as described above for the elevator equipment room heat detectors.
- F. Initiate a trouble tone and illuminate an LED light on the FACP to indicate a trouble condition under the following conditions:
 1. System wiring short circuit, open circuit or short to ground condition
 2. Failure of audio amplifier
 3. Failure of tone-generating equipment
 4. Failure of primary or secondary power supply
 5. Missing or failed initiating device
- G. Initiate a supervisory tone and illuminate an LED light on the FACP to provide supervision of each distinct device under the following conditions:
 1. Activation of a sprinkler valve status switch
 2. Activation of a sprinkler post indicator valve
- H. Provide supervision and indication for certain non-system equipment on the FACP. Provide necessary relays with dry contacts at the equipment and monitor modules for the following points:
 1. Elevator shunt-trip power "ON"
- I. Provide a Digital Alarm Communicator Transmitter (DACT) for signaling the central monitoring service that an alarm, trouble or supervisory alert condition exists at the facility. Provide equipment with the following:
 1. UL listing for fire reporting to a Central Station and meet performance requirements of NFPA 72.
 2. Battery backup.
 3. Supervise wiring from the FACP to the DACT
- J. Upon initiation of alarms in zone(s) with power operated doors in rated walls, send these doors a signal to disable automatic operation and to release any specific locking function. Coordinate with door hardware schedule and specifications

1.07 QUALITY ASSURANCE

- A. Copies of Design Criteria Documents: Maintain at the project site for the duration of the project, bound together, an original copy of NFPA 72, the relevant portions of applicable codes, and instructions and guidelines of authorities having jurisdiction; deliver to Owner upon completion.
- B. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.
- C. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
 3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
- D. Maintenance Contractor Qualifications: Same entity as installer.

1.08 WARRANTY

- A. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.

- B. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fire Alarm Control Units: Provided their products meet or exceed the performance of the basis of design product, products of the following are acceptable:
 - 1. Honeywell Security & Fire Solutions/Gamewell-FCI: www.gamewell-fci.com.
 - 2. Honeywell Security & Fire Solutions/Fire-Lite: www.firelite.com.
 - 3. Honeywell Security & Fire Solutions/Notifier: www.notifier.com.
 - 4. Honeywell Security & Fire Solutions/Silent Knight: www.silentknight.com.
 - 5. Honeywell Security & Fire Solutions/Vista: www.security.honeywell.com.
 - 6. Siemens Building Technologies, Inc: www.usa.siemens.com.
 - 7. Simplex, a Tyco Business: www.simplex-fire.com.
- B. Substitutions: See Section 01 6000 - Product Requirements.
 - 1. For other acceptable manufacturers of control units specified, submit product data showing equivalent features and compliance with contract documents.
 - 2. For substitution of products by manufacturers not listed, submit product data showing features and certification by Contractor that the design will comply with contract documents.

2.02 FIRE ALARM SYSTEM

- A. Fire Alarm System: Provide a new automatic fire detection and alarm system:
 - 1. Provide all components necessary, regardless of whether shown in the contract documents or not.
 - 2. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
 - a. ADA Standards.
 - b. The requirements of the State Fire Marshal.
 - c. The requirements of the local authority having jurisdiction .
 - d. Applicable local codes.
 - e. The contract documents (drawings and specifications).
 - f. NFPA 101.
 - g. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
 - 3. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
 - 4. Hearing Impaired Occupants: Provide visible notification devices in all public areas and in dwelling units.
 - 5. Combined Systems: Do not combine fire alarm system with other non-fire systems.
- B. Supervising Stations and Fire Department Connections:
 - 1. Public Fire Department Notification: By on-premises supervising station.
 - 2. Means of Transmission to Remote Supervising Station: Digital alarm communicator transmitter (DACT), 2 telephone lines.
- C. Circuits:
 - 1. Initiating Device Circuits (IDC): Class B, Style C.
 - 2. Signaling Line Circuits (SLC) : Class B, Style 4.
 - 3. Notification Appliance Circuits (NAC): Class B, Style Y.
- D. Spare Capacity:
 - 1. Initiating Device Circuits: Minimum 25 percent spare capacity.

2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
 3. Speaker Amplifiers: Minimum 25 percent spare capacity.
 4. Master Control Unit: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.
- E. Power Sources:
1. Primary: Dedicated branch circuits of the facility power distribution system.
 2. Secondary: Storage batteries.
 3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
 4. Each Computer System: Provide uninterruptible power supply (UPS).

2.03 FIRE SAFETY SYSTEMS INTERFACES

- A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
1. Sprinkler water control valves.
 2. Elevator shut-down control circuits.
- B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
1. Sprinkler water flow.
 2. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.
 3. Duct smoke detectors.
- C. Elevators:
1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.
 2. Elevator Machine Room Heat Detector: Shut down elevator power prior to hoistway sprinkler activation.
 3. Sprinkler pressure or waterflow: Shut down elevator power prior to hoistway sprinkler activation.
- D. HVAC:
1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.
- E. Doors:
1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor.
 2. Electromagnetic Door Locks on Egress Doors: Unlock upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from.

2.04 COMPONENTS

- A. General:
1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
 2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.
- B. Fire Alarm Control Units, Initiating Devices, and Notification Appliances: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.
- C. Master Control Unit: As specified for Basis of Design above, or equivalent.
1. The fire alarm control panel shall be microprocessor based using multiple microprocessors throughout the system providing rapid processing of smoke detector and other initiation device information to control system output functions.
 2. There shall be a watchdog circuit, which shall verify the system processors and the software program. Problems with either the processors or the system program the panel shall activate a trouble signal, and reset the panel.

3. The system modules shall communicate with an RS 485 network communications protocol. All module wiring shall be to terminal blocks, which will plug into the system card cage.
 4. The system shall be capable of supporting unshielded wiring applications.
 5. The signal line circuits shall be tested for opens, shorts and communications with all addressable devices installed before connection to the control panel.
 6. The remote printer module shall provide a means for connecting the FACP system to a serial or parallel printer for creating a hard copy of system status and configuration reports. The printer module shall also provide a foreign system interface output port that can be configured to communicate with external systems, such as building management systems. The printer module shall consist of two RS-232 (serial) ports and a single parallel port allowing connection to a parallel printer. The serial port shall have the ability to be configured as RS-232 or RS-485.
- D. Power supply:
1. The system Power Supply/Charger shall be a 12-amp supply with battery charger. The power supply shall be filtered and regulated. The power supply shall have a minimum of 1 power limited output rated at 4 amps, and a minimum of 1 output rated at 12 amps. The system power supply can be expanded up to 48 amps. The auxiliary power supply module shall share common batteries with the primary power supply. The system power supply shall have 4 relays, 1 for common alarm, one for common trouble and two programmable relays. The power supply shall be rated for 120/240 VAC 50/60 Hz.
 2. The battery charger shall be able to charge the system batteries up to 100 AH batteries. Battery charging shall be microprocessor controlled and programmed with a special software package to select charging rates and battery sizes. An optional Thermistor for monitoring battery temperature to control charging rate shall be available.
 3. The power supply shall have a plug for an AC adapter cable, which allows a technician to plug in a laptop computer for up or down loading program information or test equipment.
 4. Transfer from AC to battery power shall be instantaneous when AC voltage drops to a point where it is not sufficient for normal operation.
- E. System enclosure:
1. Provide the enclosure needed to hold all the cards and modules as specified with at least spare capacity for two cards. The enclosure outer door shall be either black or red. Provide the color as to the local AHJ requirements. The outer doors shall be capable of being a left hand open or a right hand open. The inner door shall have a left hand opening. System enclosure doors shall provide where required ventilation for the modules or cards in the enclosure.
 2. Provide system enclosure for all amplifiers. Where required by the manufacturer, provide means for venting heat from the enclosure either by having enclosure sides and top vented or the doors vented.
- F. System printer:
1. The system printer shall be operated from a remote printer module which shall be mounted under a table or behind desk. This module shall provide a parallel port and 2 serial ports for RS 232 protocol. One of the serial ports shall be able to be programmed for RS485 protocol.
 2. The logging printer shall be UL listed with the system. This parallel printer shall be supervised for: On/Off line, out of paper, paper jam, power off, and connection the system. The printer shall be a; high speed, 24 dot matrix, wide carriage, and capable of using tractor or friction fed paper. Supervised network connection shall be either Style 4 or 7 as required by local requirements. The printer shall contain diagnostic LED's for ease in maintenance.
- G. Remote Annunciators:
1. Remote LCD Annunciator:

- a. Primary Acknowledge, Silence, Reset Keys, Status LEDs and LCD display similar to the FACP.
 - b. Minimum two lines of 40 characters each and four programmable control switches and associated LEDs.
 - c. Operator keys shall be keyed switch enabled to prevent unauthorized use.
- H. Initiating Devices:
- 1. Manual Pull Stations:
 - a. Provide addressable manual stations where shown on the drawings, to be flush or surface mounted as required. Manual stations shall contain the intelligence for reporting address, identity, alarm and trouble to the fire alarm control panel. The manual station communications shall allow the station to provide alarm input to the system and alarm output from the system within less than four (4) seconds.
 - b. The manual station shall be equipped with terminal strip and pressure style screw terminals for the connection of field wiring. Surface mounted stations where indicated on the drawings shall be mounted using a manufacturer's prescribed matching red enamel outlet box.
 - c. Provide double action pull station.
 - 2. Smoke Detectors:
 - a. General:
 - 1) Select smoke detectors for detection of abnormal smoke densities. Smoke detectors shall be photoelectric type.
 - 2) Detectors shall contain a visible indicator LED/LCD that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Detectors shall be the plug-in type in which the detector base contains terminals for making wiring connections.
 - 3) Detectors that are to be installed in concealed (above false ceilings, etc.) locations shall be provided with a remote indicator LED/LCD suitable for mounting in a finished, visible location.
 - 4) Detector shall be listed for duct smoke sampling when mounted in a compatible housing and shall be specifically programmable as a duct smoke detector in the software data-base. When used as a duct detector it shall support the use of a remote test switch and LED indicator.
 - 5) The detector shall have a multicolor LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm.
 - 6) The multi-criteria smoke detector shall be an intelligent digital photoelectric detector with a programmable heat detector. Detectors shall be listed for use as open area protective coverage, in duct installation and sampling assembly installation and shall be insensitive to air velocity changes.
 - 7) The intelligent smoke detector shall be capable of providing three distinct outputs from the control panel. The outputs shall be from an input of smoke obscuration, a thermal condition or a combination of obscuration and thermal conditions. The detector shall be designed to eliminate calibration errors associated with field cleaning of the chamber.
 - 8) Detectors shall be operational with addressable relay bases, addressable audible bases and remote indicating LED's, programmable by the control panel and controlled by the detector electronics. They shall be supplied and installed with one of these options where indicated on the drawings or required by the operational requirements of this specification.
 - 9) The detector shall support the use of a relay, or LED remote indicator without requiring an additional software address. Low profile, white case shall not exceed 2.5 inches of extension below the finish ceiling.
 - b. Photoelectric Detectors

- 1) Detectors shall operate on a light scattering concept using an LED light source. Failure of the LED shall not cause an alarm condition. Detectors shall be factory set for sensitivity and shall require no field adjustments of any kind. Detectors shall have an obscuration rating in accordance with UL 268. Addressable smoke detectors shall be capable of having the sensitivity being remotely adjusted by the control panel.
- c.
3. Duct Smoke Detectors:
 - a. For duct detector applications, the smoke detector shall be an intelligent digital photoelectric detector with a programmable heat detector. Detectors shall be listed for use as open area protective coverage, in duct installation and sampling assembly installation and shall be insensitive to air velocity changes.
 - b. The detector communications shall allow the detector to provide alarm input to the system and alarm output from the system within four (4) seconds. The detector shall be mounted in a duct detector housing listed for that purpose. The duct detector shall support the use of a remote test switch, relay or LED remote indicator. The duct detector shall be supplied with the appropriate sampling tubes to fit the installation.
 - c. Where duct detectors are exposed to the weather a weatherproof enclosure shall be available. The duct housing cover shall include a test port for functional testing of the detector without cover removal. The duct housing shall include a cover removal switch capable of indicating cover removal status to the fire alarm control panel.
 - d. Where required there shall be available a duct housing with an on-board relay. Also where required, there shall be a standalone housing available with its own power supply and test/reset switch that does not require connection to a fire alarm control panel.
4. Detector Bases:
 - a. Detector bases shall be low profile twist lock type with screw clamp terminals and self-wiping contacts. Bases shall be installed on an industry standard, 4" square or octagonal electrical outlet box.
 - b. Where selective localized control of electrical devices is required for system operation, furnish and install detector base with software programmed addressable relay integral to the base. The relay shall switch electrical loads within relay ratings, as indicated on the drawings. Operation of the addressable control circuit shall be independent of the number of detectors and relays on the circuit or the number in an alarm state. Relay bases shall be rated for resistive or inductive load (120 VAC or 30 VDC) 3 amps.
 - c. Where indicated on the drawings, furnish detector base with integral approved audible evacuation alarm signal having an output of 85db @ 10'. The audible signal shall be individually addressable and software programmed for operation.
5. Heat Detectors:
 - a. General:
 - 1) Design heat detectors for detection of fire by fixed temperature. Heat detector spacing shall be rated in accordance with UL 521. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations as defined by NFPA, shall be types approved for such locations. Heat detectors located in attic spaces or similar concealed spaces below the roof shall be intermediate temperature rated
 - 2) Thermal detectors shall be rated at 135 degrees fixed temperature and 15 degrees per minute rate of rise. Detectors shall be constructed to compensate for the thermal lag inherent in conventional type detectors due to the thermal mass, and alarm at the set point of 135 degrees Fahrenheit. The choice of alarm reporting as a fixed temperature detector or a combination of fixed and rate of rise shall be made in system software and be changeable at any time without the necessity of hardware replacement.

- 3) The detectors furnished shall have a listed spacing for coverage up to 2,500 square feet and shall be installed according to the requirements of NFPA 72 for open area coverage.
- b. Combination Fixed-Temperature and Rate-of-Rise Detectors:
 - 1) Detectors shall be selected for semi-flush outlet box mounting and supported independently of wiring connections. Contacts shall be self-resetting after response to rate-of-rise principle.
 - 2) Under fixed temperature actuation, the detector shall have a permanent external indication which is readily visible. Detector units located in boiler rooms, showers, or other areas subject to abnormal temperature changes shall operate on fixed temperature principle only.
 - 3) The UL 521 test rating for the fixed temperature portion shall be 135 degrees F. The UL 521 test rating for the Rate-of-Rise detectors shall be rated for 50 by 50 ft.
- c. Rate Compensating Detectors:
 - 1) Detectors shall be surface mounted vertical type, with outlet box supported independently of wiring connections. Detectors shall be hermetically sealed and automatically resetting. Rate Compensated detectors shall be rated for 50 by 50 ft.
- d. Fixed Temperature Detectors:
 - 1) Detectors shall be designed for surface outlet box mounting and supported independently of wiring connections. Detectors shall be designed to detect high heat. The detectors shall have a specific temperature setting of 135 degrees F as shown. The UL 521 test rating for the fixed temperature detectors shall be rated for 15 by 15 ft.
6. Addressable Interface Devices:
 - a. Addressable interface devices shall be provided to monitor contacts for such items as water-flow, tamper, and PIV switches (non-addressable devices) connected to the fire alarm system. These interface devices shall be able to monitor a single or dual contacts and be configurable to monitor normally open or normally closed devices for both alarm and trouble indications. An address will be provided for each contact. Where remote supervised relay is required the interface shall be equipped with a SPDT relay rated for 4 amps resistive and 3.5 amps inductive.
 - b. The devices shall have both an input and output address. The supervision shall detect a short of the supervised circuit and shall prevent power from being applied to the circuit. The device shall have an integral LED that provide indication of power and flashes each time the devices is polled.
 - c. Where needed a conventional zone module shall connect to the signal line circuit, which will allow the use of conventional initiation devices. This module shall have the ability to support up to 15 convention smoke detectors and an unlimited number of contact devices. This module shall also be capable of monitoring linear beam detectors and conventional Flame detectors.
 - d. Single device damper monitoring and control: When connected to the FACP, a single switch input shall be able to monitor all 3 states of a damper - open, closed, and in transit. When connected to a FACP, a single relay shall be able to fully control a damper (through the relay connected to the motor control) while also using its switch input for monitoring all 3 states of the damper.
 - e. Devices shall be UL listed for fire alarm use and compatible with the the fire alarm control unit. The devices shall be capable of mounting in a standard electrical outlet box with cover plates to allow surface or flush mounting.
- I. Notification Appliances:
 1. Horn/Strobe:

- a. The horn shall be UL Listed under Standard 464 for Audible Signal Appliances, and horns equipped with strobes shall be listed under UL Standard 1971 for Emergency Devices for the Hearing-Impaired
 - b. Strobes shall be certified to meet the requirements of FCC Part 15, Class B, and shall incorporate low- temperature compensation to ensure the lowest possible current consumption
 - c. All horns shall use solid state components, and shall provide field-selectable, single-stroke or vibrating operation with volume-and-tone control
 - d. All models shall have a peak anechoic sound output of 83 dB at 10 feet and an adjustable frequency range of 800 to 1200 Hz.
 - e. All inputs shall employ terminals that accept #12 to #18 AWG wire sizes
 - f. Strobe portion of the appliance shall produce a flash rate of one (1) flash per second over the Regulated Input Voltage Range, and shall incorporate a Xenon flashtube enclosed in a rugged Lexan® lens
 - g. Strobe shall be of low-current design, and where Multi-Candela Chime Strobes are specified, the strobe intensity shall have field-selectable settings and shall be rated per UL Standard 1971 at:
 - 1) 15/30/75/110cd for wall mount
 - 2) 15/30/75/95cd or 115/177cd for ceiling mount
 - h. The selector switch for selecting the candela shall be tamper resistant and not accessible from the front of the appliance
 - i. Synchronization shall be possible with built-in sync protocol
 - j. The strobes shall not drift out of synchronization at any time during operation
 - k. If the sync module or Power Supply fails to operate, (i.e., contacts remain closed), the strobe shall revert to a non-synchronized flash rate
 - l. The horn and the horn-strobe appliances shall be designed for indoor surface or flush mounting
 - m. The horn and horn strobe shall incorporate a chime mounting plate with a grille cover which is secured with two screws for a level, finish and shall mount to standard electrical hardware requiring no additional trim plate or adapter
 - n. All notification appliances shall be listed for "Special Applications"
2. Strobes:
- a. The strobes shall meet and be listed for UL Standard 1971 (Emergency Devices for the Hearing-Impaired) for Indoor Fire Protection Service
 - b. Strobe shall be listed for indoor use, and shall meet the requirements of FCC Part 15 Class B
 - c. Strobe appliances shall produce a flash rate of one (1) flash per second over the Regulated Voltage Range, and shall incorporate a Xenon flashtube enclosed in a rugged Lexan® lens
 - d. All inputs shall be compatible with standard, reverse polarity supervision of circuit wiring by a Fire-Alarm Control Panel (FACP).
 - e. The Strobe shall be of low-current design.
 - f. The strobe intensity shall have field-selectable settings, and shall be rated per UL Standard 1971 for 15/30/75/95cd or 115/177cd for ceiling mount where Multi-Candela appliances are specified.
 - g. The selector switch for selecting the candela shall be tamper resistant.
 - h. The appliance shall be compatible with power supplies with built-in sync protocol when synchronization is required.
 - i. The strobes shall not drift out of synchronization at any time during operation
 - j. If the sync module or Power Supply fails to operate, (i.e. - contacts remain closed), the strobe shall revert to a non-synchronized flash rate.
 - k. The strobes shall be designed for indoor surface of flush mounting.

- I. The Strobe Plate shall mount to either a standard, 4-inch square back box for flush mounting, or shall mount to the back box for surface mounting.
- J. Isolator Module:
 1. Provide modules to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch, limiting the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch to no more than 20.
 2. Provide at least one isolator module for each floor or protected zone of the building.
 3. Provide automatic disconnection of the SLC when a wire-to-wire short occurs with automatic reconnection of the isolated section and when the short circuit condition is corrected.
- K. Digital communicator:
 1. The Multi-Point Digital Alarm Communicator shall be UL864 listed to provide point identification of alarm, supervisory, security and trouble events to a Central or Remote Receiving Station. The Communicator shall support the following:
 - a. Ademco Contact ID or SIA protocol.
 - b. Ademco Contact ID selection shall provide the ability to transmit events for up to 999 individual points.
 - c. SIA selection shall provide the ability to transmit events for up to 2040 individual points.
 - d. Programming of accounts and phone numbers.
 - e. Dual phone line interface.
 - f. Line fault monitoring.
 - g. Automatic 24-hour test
- L. Dialer:
 1. The dialer shall be listed with the system and shall have a minimum of 4 channels. The dialer shall be mounted externally.
- M. Circuit Conductors: Copper; provide 200 feet extra; color code and label.
- N. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
 1. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.
 2. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.
 3. Signaling Line Circuits: Provide surge protection at each point where circuit exits or enters a building, rated to protect applicable equipment.
- O. Locks and Keys: Deliver keys to Owner.
- P. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
 1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
 2. Provide one for each control unit where operations are to be performed.
 3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
 4. Provide extra copy with operation and maintenance data submittal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, the contract documents and in accordance with the manufacturer's diagrams and recommendations.

- B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- C. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- D. Obtain Owner's approval of locations of devices, before installation.
- E. Install instruction cards and labels.
- F. Wiring Installation:
 - 1. Install wiring in metallic conduit. Each conductor shall be identified with wire markers at terminal points and junction boxes. Attach the markers within two inches of the wire termination.
 - 2. Obtain from Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. Make no deviation from the written instructions without prior written approval from the Fire Alarm System manufacturer and engineer of record.
 - 3. Color-code fire alarm conductors differently from normal building power wiring. Use one color code for alarm initiating circuit wiring and a different color code for supervisory circuits. Color code notification appliance circuits differently from alarm initiating circuits. Use a consistent color code throughout the installation.
 - 4. Install at least two vertical cable risers to serve the fire alarm system. Separate risers that are in close proximity to each other, in accordance with NFPA 72, with a minimum 2-hour rated cable assembly, 2-hour rated shaft or enclosure or 2-hour rated stairwell so that the loss of one riser does not prevent the receipt or transmission of signal from other floors or zones.
 - 5. Install wiring to central station transmitter in a one inch conduit from FACP to the central station transmitter connection. Install the quantity of conductors and electrical supervision for connecting wiring as required to suit the central station monitoring function.
 - 6. For each exterior circuit, in addition to the number of panel wires required, provide a green grounding conductor for operation of transient protection cube. Obtain ground at panel nearest to the point of cube application, but in no case exceed 28 feet of wire length.
 - 7. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors in the system is prohibited. Wiring within any control equipment shall be readily accessible without removing any component parts. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.
 - 8. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire connected to the building ground system to fire-alarm control unit.
 - 9. Ground shielded cables at the control panel location only. Insulate shield at device location.
- G. Provide on-premise warranty service during normal working hours at no cost for a period of twelve months from date of completion and acceptance.
- H. Smoke detectors:
 - 1. For addressable smoke detectors, permanently write the address in the base so that it is visible with the smoke head removed, where the address is contained in the smoke head.
 - 2. Mount ceiling smoke detectors no less than 3 feet from a supply, return or exhaust air diffusers, and 3 feet from electronic ballasts. Coordinate with Division 15 for diffuser locations.
 - 3. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
 - 4. Detectors installed in concealed locations (above ceiling, raised floors, etc.) shall have a remote visible indicator LED/LCD in a finished, visible location as indicated.

5. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.
- I. Duct mounted smoke detectors:
 1. Provide duct smoke detectors as specified on Division 23 drawings for HVAC supply, return and exhaust fans and ducts. Refer to Division 23 drawings for location and quantities.
 2. Install duct smoke detectors in the supply air stream of an air handling unit downstream of filters and at least 6 feet from humidifier, preferably upstream.
 3. Install duct smoke detectors within 5 feet of smoke dampers where required.
 4. Install duct smoke detectors in the return air stream of an air handling unit on upstream side of outside air inlet.
 5. Furnish and connect duct detectors under this Division but install them under Division 23.
 6. Support sampling tube within the duct and extend at least 3/4 of the distance across the duct.
 7. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
 8. Mount detectors the appropriate distance from ells, turns, etc. as required by the detector manufacturer.
 9. Where duct detectors are mounted above ceilings or above 6 feet in mechanical rooms, provide remote LED alarm light and test switch in ceiling close to detector or surface mounted on an adjacent wall of mechanical room.
 - J. Alarm Devices:
 1. Wire flashing lights separately from audible alarms. When alarm signal is silenced, lights shall continue to flash until the condition responsible for the system alarm has been cleared and reset.
 2. Provide synchronized visual devices throughout project.
 3. Comply with ADA regulations for mounting of strobe units. Depending upon the configuration of the strobe unit, utilize mounting requirements as follows:
 - a. Mount strobe unit 80 inches to bottom of the device faceplate, measured from the highest floor level of area served or not less than six inches below ceiling levels, whichever is lower.
 - b. Entire lens shall not be less than 80 inches or greater than 96 inches above the finished floor.
 4. Locate visual alarm devices in corridors per the plans but no more than 15 feet from the end of a corridor or an interruption of the viewing path such as a corridor door or an elevation change. Locate devices in corridors no more than 100 feet apart.
 5. Locate and mount to maintain a minimum 36 inches (900 mm) clearance from side obstructions.
 6. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
 - K. Manual Fire-Alarm Boxes:
 1. Install manual fire-alarm box in the normal path of egress within 60 inches of a stair or the exit doorway.
 2. Mount manual fire-alarm box on a background of a contrasting color.
 3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level to bottom of device. All devices shall be mounted at the same height unless otherwise indicated.
 - L. Water Flow and Tamper Switches:

1. Assign a separately addressable, supervised point and annunciate separately each water flow switch and each valve tamper switch.
 2. Connect sprinkler water flow switches, provided under Division 21, to the fire alarm system. Refer to Division 21 drawings for location and quantity of flow switches.
 3. Install a valve status switch, furnished under Division 21, on each sprinkler system valve and PIV (Post Indicator Valve). Refer to plumbing drawings and sprinkler system shop drawings for exact location and quantity of valve status switches and PIV switches.
 4. Where possible, locate water flow and pressure switches a minimum of 12 inches from a fitting that changes the direction of the flow and a minimum of 36 inches from a valve.
- M. Addressable Control Module:
1. Addressable and control modules shall be installed in the outlet box or adjacent to the device they are controlling. If a supplementary suppression releasing panel is provided, then the monitor modules shall be mounted in a common enclosure adjacent to the suppression releasing panel and both this enclosure and the suppression releasing panel shall be in the same room as the releasing devices.
 2. All control modules are used as interfaces to other systems, such as HVAC or elevator control, they shall be within the control panel or immediately adjacent to it. Control modules that control a group of notification appliances shall be adjacent to the first notification appliance in the notification appliance circuits
 3. Control modules that connect to auxiliary systems or interface with other systems (non-life safety systems) and where not required by NFPA 72, shall not require the secondary circuits to be supervised. Contacts in suppression systems and other fire protection sub-systems shall be connected to the fire alarm system to perform required alarm functions as indicated on the drawings and as specified herein.
 4. Mount valve tamper switches so as not to interfere with the normal operation of the valve and adjust to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than 1/5 of the distance from its normal position.
 5. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
- N. System is to automatically actuate certain control functions and monitor or supervise points. Electrically supervise wiring to auxiliary fire alarm relays used to activate such functions or monitor/supervise points. Locate relays within three feet of the device controlled, such as a motor starter. Functions for which circuits are to be supervised include, but are not limited to, the following:
1. Release of door hold-open devices
 2. Shutdown of selected HVAC systems or activation of smoke control systems
 3. Elevator shunt trip power
 4. Disconnect switch position on smoke control equipment

3.02 INSPECTION AND TESTING FOR COMPLETION

- A. Provide Engineer and Owner 7 days minimum notice prior to beginning completion inspections and tests. Send notice after pre-testing confirming that the system conform to the drawings and specifications and malfunctioning or damaged devices have been replaced.
- B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E. Provide all tools, software, and supplies required to accomplish inspection and testing.

- F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- G. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
- H. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.
 - 1. Record all system operations and malfunctions.
 - 2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
 - 3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
 - 4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.03 FIELD QUALITY CONTROL

- A. Testing, general:
 - 1. Provide the service of a NICET level III, competent, factory trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.
 - 2. All Alarm Initiating Devices shall be observed and logged for correct zone and sensitivity. These devices and their bases shall be tagged with adhesive tags located in an area not visible when installed, showing the initials of the installing technician and date.
 - 3. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.
 - 4. The acceptance inspector shall be notified before the start of the required tests. All items found at variance with the drawings or this specification during testing or inspection by the acceptance inspector shall be corrected.
 - 5. Test reports shall be delivered to the acceptance inspector as completed.
 - 6. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installing contractor. The following equipment shall be a minimum for conducting the tests:
 - a. Ladders and scaffolds as required to access all installed equipment.
 - b. Multi-meter for reading voltage, current and resistance.
 - c. Two way radios, and flashlights.
 - d. A manufacturer recommended device for measuring air flow through air duct smoke detector sampling assemblies.
 - e. Decibel meter.
 - f. In addition to the testing specified to be performed by the installing contractor, the installation shall be subject to test by the acceptance inspector.
- B. Preliminary Tests:
 - 1. Upon completion of the installation, subject the system to functional and operational performance tests including tests of each installed initiating and notification appliance, when required.
 - 2. Tests shall include the meggering of system conductors to determine that the system is free from grounded, shorted, or open circuits. Conduct the megger test prior to the installation of fire alarm equipment. If deficiencies are found, corrections shall be made and the system shall be retested to assure that it is functional.
 - 3. After completing the preliminary testing complete and submit the NFPA 72, Certificate of Completion.
 - 4. Do not perform acceptance testing until the Contractor has completed and submitted the Certificate of Completion. Testing shall be in accordance with NFPA 72. The recommended tests in NFPA 72 shall be considered mandatory and shall verify that previous deficiencies have been corrected.

3.04 ACCEPTANCE TESTING

- A. Prior to final acceptance a minimum 30 days "burn in" period shall be provided. The purpose shall be to allow equipment to stabilize and potential installation and software problems and equipment malfunctions to be identified and corrected. During this diagnostic period, all system operations and malfunctions shall be recorded. Final acceptance will be made upon successful completion of the "burn in" period and where the last 15 days is without a system or equipment malfunction.
- B. A written acceptance test procedure (ATP) for testing the fire alarm system components and installation will be prepared by the engineer in accordance with NFPA 72 and this specification. The contractor shall be responsible for the performance of the ATP, demonstrating the function of the system and verifying the correct operation of all system components, circuits, and programming.
- C. A program matrix shall be prepared by the installing contractor referencing each alarm input to every output function affected as a result of an alarm condition on that input.
- D. The installing contractor prior to the ATP shall prepare a complete listing of all device labels for alphanumeric annunciator displays.
- E. The acceptance inspector shall use the system record drawings in combination with the documents specified in this specification during the testing procedure to verify operation as programmed. In conducting the ATP, the acceptance inspector shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:
 - 1. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
 - a. Open, shorted and grounded signal line circuits.
 - b. Open, shorted and grounded notification, releasing circuits.
 - c. Primary power or battery disconnected.
 - 2. System notification appliances shall be demonstrated as follows:
 - a. All alarm notification appliances actuate as programmed
 - b. Audibility and visibility at required levels.
 - 3. System indications shall be demonstrated as follows:
 - a. Correct message display for each alarm input at the control display.
 - b. Correct annunciator light for each alarm input at each annunciator and graphic display as shown on the drawings.
 - c. Correct history logging for all system activity.
 - 4. System off-site reporting functions shall be demonstrated as follows:
 - a. Correct zone transmitted for each alarm input
 - b. Trouble signals received for disconnect
 - 5. Secondary power capabilities shall be demonstrated as follows:
 - a. System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
 - b. System primary power shall be restored for forty-eight hours and system-charging current shall be normal trickle charge for a fully charged battery bank.
 - c. System battery voltages and charging currents shall be checked at the fire alarm control panel.

3.05 DOCUMENTATION

- A. System documentation shall be furnished to the owner and shall include but not be limited to the following:

1. System record drawings and wiring details including one set of reproducible drawings, and a CD ROM with copies of the record drawings in DXF format for use in a CAD drafting program.
2. System operation, installation and maintenance manuals.
3. System matrix showing interaction of all input signals with output commands.
4. Documentation of system voltage, current and resistance readings taken during the installation, testing and ATP phases of the system installation.
5. System program showing system functions, controls and labeling of equipment and devices.

3.06

3.07 OWNER PERSONNEL INSTRUCTION

- A. Provide the following instruction to designated Owner personnel:
 1. Hands-On Instruction: On-site, using operational system.
 2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
- B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
 1. Initial Training: 1 session pre-closeout.
- C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
 1. Initial Training: 1 session pre-closeout.
- D. Maintenance Technicians: Detailed training for electrical technicians, on programming, maintaining, repairing, and modifying; factory training:
 1. Initial Training: One 3-day session, pre-closeout.
- E. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.08 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 1. Be prepared to conduct any of the required tests.
 2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 3. Have authorized technical representative of control unit manufacturer present during demonstration.
 4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
 5. Repeat demonstration until successful.
- B. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
 1. Specified diagnostic period without malfunction has been completed.
 2. Approved operating and maintenance data has been delivered.
 3. Spare parts, extra materials, and tools have been delivered.
 4. All aspects of operation have been demonstrated to Owner.
 5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
 6. Occupancy permit has been granted.
 7. Specified pre-closeout instruction is complete.

3.09 MAINTENANCE

- A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

- B. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.
- C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
 - 1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
 - 2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
 - 3. Record keeping required by NFPA 72 and authorities having jurisdiction.
- D. Provide trouble call-back service upon notification by Owner:
 - 1. Provide on-site response within 2 hours of notification.
 - 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 - 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
- F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.
- G. Comply with Owner's requirements for access to facility and security.

END OF SECTION

SECTION 27 5117
PUBLIC ADDRESS SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Amplifier and control equipment.
- B. Input equipment.
- C. Sound system cable.

1.02 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0537 - Pull and Junction Boxes.

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SYSTEM DESCRIPTION

- A. Public address system for voice and music.
- B. Input components:
 - 1. AM/FM tuner.
- C. Features:
 - 1. Interface to telephone system.
 - 2. One-way paging .
 - 3. Distribution of background music.

1.05 SUBMITTALS

- A. Product Data: Provide data showing electrical characteristics and connection requirements for each component.
- B. Operation Data: Include instructions for adjusting, operating, and extending the system.
- C. Maintenance Data: Include repair procedures and spare parts documentation.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70 .
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Aiphone Corporation: www.aiphone.com.
- B. GE Security, Sound and Communications: www.gesecurity.com/sac.
- C. Toa Electronics, Inc: www.toa.jp.

2.02 AMPLIFICATION AND CONTROL EQUIPMENT

- A. Auxiliary Inputs: 2 high impedance input with 0.4 volt sensitivity and noise level at least 70 dB below rated output.
- B. System Frequency Response: 50 to 15,000 Hz, plus or minus 2 dB.
- C. System Distortion: Less than 1.5 percent, 100 to 100,000 Hz at rated power.
- D. System Output: 4 ohms 25 volts.
- E. Volume Controls: One for each input and one master volume.
- F. Bass Control: Plus 8 dB to minus 12 dB at 50 Hz.

- G. Treble Control: Plus 8 dB to minus 12 dB at 10,000 Hz.
- H. Program Selector: Provide program and mode selector switches.

2.03 COMPONENTS

- A. AM/FM Tuner: Tuner with 525 to 1605 kHz AM and 88 to 108 MHz FM tuning range.
 - 1. AM Performance:
 - a. AM Antenna Input: 75 ohms, unbalanced.
 - 2. FM Performance:
 - a. FM Antenna Input: 300 ohms, balanced.
- B. Speakers: 8 inch coaxial speaker with integral crossover circuit.
 - 1. Power Rating: 20 watts.
 - 2. Frequency Range: 45 to 18,000 Hz.
- C. Speaker Baffles and Enclosure: Round, painted steel, with uniform perforations.
 - 1. Size: 12 inch.
 - 2. Finish: White.
 - 3. Speaker Backbox: Insulated with sound-deadening material.
- D. Horns: Wide dispersion indoor/outdoor horn with driver.
 - 1. Power Rating: 60 watts.
 - 2. Low Frequency Cutoff: 250 Hz.
 - 3. Sound Distribution: 20 x 50 degrees.
- E. Matching Transformers: Tapped from 0.5 to 4 watts in 1 watt steps, with primary/secondary ratio to match amplifier to speaker impedances.
- F. Telephone Interface: 600 ohm - auxiliary input.
- G. Antenna: Folded dipole FM antenna.
 - 1. Impedance: 300 ohm with matching transformer for 75 ohm coaxial cable.

2.04 WIRE AND CABLE

- A. Input Cable: 22 AWG copper conductor, 300 volt insulation, rated 60 degrees C, paired conductors twisted together, shielded, and covered with a PVC jacket.
- B. Speaker Wire and Cable: 22 AWG copper conductor, 300 volt insulation, rated 60 degrees C, paired conductors twisted together shielded and covered with a PVC jacket.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Mounting Heights: Coordinate locations of outlet boxes specified in Section 26 0537 to obtain mounting heights indicated.
- C. Splice cable only in accessible junction boxes or at terminal block units.
- D. Make cable shields continuous at splices and connect speaker circuit shield to equipment ground only at amplifier.
- E. Install input circuits in separate cables and raceways from output circuits.
- F. Provide protection for exposed cables where subject to damage.
- G. Use armored cable for outside speaker circuits.
- H. Support cables above accessible ceilings to keep them from resting on ceiling tiles. Use spring metal clips or plastic cable ties to support cables from structure for ceiling suspension system. Include bridle rings or drive rings.
- I. Use suitable cable fittings and connectors.
- J. Connect reproducers to amplifier with matching transformers.

- K. Ground and bond equipment and circuits in accordance with Section 26 0526.

3.02 ADJUSTING

- A. Adjust transformer taps for appropriate sound level.
- B. Adjust devices and wall plates to be flush and level.

3.03 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Briefly describe function, operation, and maintenance of each component.

END OF SECTION