

SECTION 23 0529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Support and attachment components for equipment, piping, and other HVAC/hydraulic work.

1.2 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2015.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.

1.3 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.
- B. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

PART 2 PRODUCTS

2.1 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 plumbing work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 4. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

- b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. 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. Comply with MFMA-4.
- C. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
- D. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- 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.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F. 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. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- G. Secure fasteners according to manufacturer's recommended torque settings.
- H. Remove temporary supports.

END OF SECTION

SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition; 2016.
- B. ASHRAE Std 110 - Methods of Testing Performance of Laboratory Fume Hoods; 2016.
- C. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2008 (Reaffirmed 2017).
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2002.

1.3 SUBMITTALS

- A. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- B. 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. Include at least the following in the plan:
 - a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - b. Final test report forms to be used.
 - c. Procedures for formal deficiency reports, including scope, frequency and distribution.
- C. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - 3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 5. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
 - 2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 - 3. SMACNA (TAB).
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.

3.2 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- 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.

3.3 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 - 1. Manufacturer.
 - 2. Model/Frame.
 - 3. HP/BHP.
 - 4. Phase, voltage, amperage; nameplate, actual, no load.
 - 5. RPM.
 - 6. Service factor.
- B. Air Cooled Condensers:
 - 1. Identification/number.
 - 2. Location.
 - 3. Manufacturer.
 - 4. Model number.
- C. Air Moving Equipment:
 - 1. Location.
 - 2. Manufacturer.
 - 3. Model number.
 - 4. Serial number.
 - 5. Arrangement/Class/Discharge.
 - 6. Air flow, specified and actual.
 - 7. Return air flow, specified and actual.
 - 8. Outside air flow, specified and actual.
- 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.
- E. Duct Traverses:
 - 1. System zone/branch.
 - 2. Duct size.
 - 3. Area.
 - 4. Design velocity.
 - 5. Design air flow.
 - 6. Test velocity.
 - 7. Test air flow.
 - 8. Duct static pressure.

END OF SECTION

SECTION 23 0713
DUCT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Duct insulation.
- B. Duct liner.

1.2 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2017.
- B. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013.
- C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014.
- D. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2019.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2016.
- F. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015.
- G. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

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

2.2 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. 'K' ('Ksi') value: 0.36 at 75 degrees F (0.052 at 24 degrees C), when tested in accordance with ASTM C518.

2.3 GLASS FIBER, RIGID

- A. Insulation: ASTM C612; rigid, noncombustible blanket.
 - 1. 'K' ('Ksi') Value: 0.24 at 75 degrees F (0.036 at 24 degrees C), when tested in accordance with ASTM C518.

2.4 DUCT LINER

- A. Glass Fiber Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; flexible blanket, rigid board, and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.
 - 1. Fungal Resistance: No growth when tested according to ASTM G21.
 - 2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F (0.045 at 24 degrees C).
 - 3. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm (25.4 m/s), minimum.
 - 4. Minimum Noise Reduction Coefficients:

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

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

END OF SECTION

SECTION 23 3100
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal ductwork.

1.2 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015, with Editorial Revision (2016).
- B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).

PART 2 PRODUCTS

2.1 DUCT ASSEMBLIES

- A. Regulatory Requirements: Construct ductwork to NFPA 90A standards.
- B. Ducts: Galvanized steel, unless otherwise indicated.
- C. Low Pressure Supply (Heating Systems): 1/2 inch w.g. (125 Pa) pressure class, galvanized steel.
- D. Low Pressure Supply (System with Cooling Coils): 1/2 inch w.g. (125 Pa) pressure class, galvanized steel.
- E. General Exhaust: 1/2 inch w.g. (125 Pa) pressure class, galvanized steel.

2.2 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.

2.3 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
- B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. 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 of perforated metal with glass fiber insulation.

- D. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
- E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- F. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).

2.4 MANUFACTURED DUCTWORK AND FITTINGS

- A. Spiral Ducts: Round spiral lockseam duct with galvanized steel outer wall.
 - 1. Manufacture in accordance with SMACNA (DCS).
- B. Round Ducts: Round lockseam duct with galvanized steel outer wall.
 - 1. Manufacture in accordance with SMACNA (DCS).
- C. Flexible Ducts: Two ply vinyl film supported by helically wound spring steel wire.
 - 1. Pressure Rating: 10 inches WG (2.50 kPa) positive and 1.0 inches WG (250 Pa) negative.
 - 2. Maximum Velocity: 4000 fpm (20.3 m/sec).
 - 3. Temperature Range: Minus 10 degrees F to 160 degrees F (Minus 23 degrees C to 71 degrees C).
- D. Round Duct Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install in accordance with manufacturer's instructions.
- C. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- D. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

END OF SECTION

SECTION 23 3300
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

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

PART 2 PRODUCTS

2.1 AIR TURNING DEVICES/EXTRACTORS

- A. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.2 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.

2.3 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.

2.4 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Flexible Duct Connections: Fabric crimped into metal edging strip.

2.5 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Single Blade Dampers:
 - 1. Fabricate for duct sizes up to 6 by 30 inch (150 by 760 mm).
 - 2. Blade: 24 gage, 0.0239 inch (0.61 mm), minimum.
- C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 by 72 inch (200 by 1825 mm). Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

1. Blade: 18 gage, 0.0478 inch (1.21 mm), minimum.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 3100 for duct construction and pressure class.
- B. 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 for cleaning kitchen exhaust ducts in accordance with NFPA 96. Provide minimum 8 by 8 inch (200 by 200 mm) size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch (100 by 100 mm) for balancing dampers only. Review locations prior to fabrication.
- C. Provide duct test holes where indicated and required for testing and balancing purposes.
- D. 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.

END OF SECTION

SECTION 23 3700
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Diffusers.
- B. Registers/grilles.
- C. Louvers.
- D. Gravity ventilators.

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS

- A. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2011 with Addendum 1.
- B. AMCA 511 - Certified Ratings Program for Air Control Devices; 2010.
- C. AMCA 550 - Test Method for High Velocity Wind Driven Rain Resistant Louvers; 2015.
- D. ASHRAE Std 130 - Methods of Testing Air Terminal Units; 2016.
- E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2014.
- F. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2013.
- G. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.
- H. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).

1.4 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.

PART 2 PRODUCTS

2.1 RECTANGULAR CEILING DIFFUSERS

- A. Type: Provide square, adjustable pattern, stamped, multi-core and _____ diffuser to discharge air in 360 degree, four way, and _____ pattern with sectorizing baffles where indicated.

- B. Connections: Round.
- C. Frame: Provide surface mount, inverted T-bar, and _____ type. In plaster ceilings, provide plaster frame and ceiling frame.
- D. Fabrication: Steel with baked enamel finish.
- E. Color: As indicated.
- F. Accessories: Provide radial opposed blade volume control damper; removable core and _____ with damper adjustable from diffuser face.

2.2 DUCT-MOUNTED SUPPLY AND RETURN REGISTERS/LOUVERS

- A. Type: Duct-mounted, rectangular register for round-spiral duct with adjustable pivot-ended blades, end caps, built-in volume damper, and dual cover flanges to lay flush on duct surface regardless of diameter. Performance to match manufacturer's catalog data.
- B. Material: 22 gage, 0.0299 inch (0.76 mm).
 - 1. Provide crossing spiral fitting-body of matching duct diameter.
- C. Color: As indicated on drawings.

2.3 CEILING EGG CRATE EXHAUST AND RETURN GRILLES

- A. Basis of Design: Krueger-HVAC; EGCX: www.krueger-hvac.com/#sle.
- B. Type: Egg crate style face consisting of 1 by 1 by 1 inch (25 by 25 by 25 mm) grid core.
- C. Color: As indicated.
- D. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting.

2.4 WALL SUPPLY REGISTERS/GRILLES

- A. Type: Streamlined and individually adjustable blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing with spring or other device to set blades, vertical face, single deflection.
- B. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting and gasket.
- C. Fabrication: Steel with 20 gage, 0.0359 inch (0.91 mm) minimum frames and 22 gage, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gage, 0.0359 inch (0.91 mm) minimum frame, or aluminum extrusions, with factory baked enamel finish.
- D. Color: As indicated.
- E. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

2.5 LOUVERS

- A. Type: 4 inch (100 mm) deep with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch (13 mm) square mesh screen over exhaust and 1/2 inch (13 mm) square mesh screen over intake.

- B. Fabrication: 16 gage, 0.0598 inch (1.52 mm) thick galvanized steel welded assembly, with factory prime coat finish.
- C. Color: As indicated.

2.6 GRAVITY VENTILATORS

A. Hood Relief Gravity Ventilator:

- 1. General:
 - a. Low silhouette for intake applications with natural gravity or negative pressure system(s).
 - b. Performance ratings and factory testing to be in accordance with AMCA 511 and AMCA 550.
 - c. Suitable for non-ducted applications.
 - d. Equipment to bear permanently affixed manufacturer's nameplate listing model and serial number.
- 2. Hood and Base:
 - a. Material: Aluminum.
 - b. Hood Construction: Precision formed, arched panels with interlocking seams.
 - c. Vertical End Panels: Fully locked into hood end panels.
 - d. Curb Cap: Pre-punched mounting holes for installation.
- 3. Birdscreen:
 - a. Fabricate in accordance with ASTM B221 (ASTM B221M).
 - b. Horizontally mounted across hood intake area.
- 4. Hood Support: Galvanized steel construction and fastened so hood can be removed completely from the base or hinged open.
- 5. Options/Accessories:
 - a. Roof Curbs:
 - 1) Pitched Roofs: Welded, straight side curb with flashing flange and wood nailer.
 - 2) Material: Aluminum.
 - 3) Insulation Thickness: 1 inch (25.4 mm).
 - b. Dampers:
 - 1) Type: Gravity.
 - 2) Factory designed to prevent outside air from entering back into building when fan is off.
 - c. Factory Finish: Thermo-setting polyester urethane.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.

- C. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- D. Install diffusers to ductwork with air tight connection.
- E. 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.
- F. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 9123.

END OF SECTION

SECTION 23 8127
SMALL SPLIT-SYSTEM HEATING AND COOLING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Ductless heat pump systems.

1.2 REFERENCE STANDARDS

- A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2008, Including All Addenda.
- B. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; 2004.
- C. ASHRAE Std 23.1 - Methods of Testing for Rating the Performance of Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Temperatures of the Refrigerant; 2010.
- D. NFPA 54 - National Fuel Gas Code; 2015.
- E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- F. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2015.
- G. NFPA 211 - Guide for Smoke and Heat Venting; 2016.
- H. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- B. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.
- C. Design Data: Indicate refrigerant pipe sizing.
- D. Manufacturer's Instructions: Indicate rigging, assembly, and installation 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 manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.4 QUALITY ASSURANCE

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

- B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of experience and approved by manufacturer.

1.5 WARRANTY

- A. Provide three year manufacturers warranty for solid state ignition modules.
- B. Provide ten year manufacturers warranty for heat exchangers, condensing units, and compressors.

PART 2 PRODUCTS

2.1 INDOOR AIR HANDLING UNITS FOR DUCTLESS SYSTEMS

- A. Manufacturers:
 - 1. Bosch Thermotechnology; _____: www.bosch-thermotechnology.us/#sle.
 - 2. Mitsubishi.
 - 3. LG.
 - 4. Daikin.
 - 5. Trane.
- B. 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. Filter return air with washable, antioxidant pre-filter and a pleated anti-allergy enzyme filter.
 - 2. Wall-Mounted Units:
- C. 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.

2.2 OUTDOOR UNITS

- A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
 - 1. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23.1 and UL 207.
- B. Compressor: Hermetic, two speed 1800 and 3600 rpm, AHRI 520 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. Coil: Air-cooled, aluminum fins bonded to copper tubes.
- D. 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.
- E. Operating Controls:
1. Control by room thermostat to maintain room temperature setting.
 2. Low Ambient Kit: Provide refrigerant pressure switch to cycle condenser fan on when condenser refrigerant pressure is above 285 psig (1965 kPa) and off when pressure drops below 140 psig (965 kPa) for operation to 0 degrees F (-18 degrees C).
- F. Mounting Pad: Formed concrete equipment pad, minimum 4 inches (100 mm) square; minimum of two located under cabinet feet.

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

- A. Install in accordance with NFPA 90A and NFPA 90B.
- B. Install gas fired furnaces in accordance with NFPA 54.
- C. Provide vent connections in accordance with NFPA 211.

END OF SECTION

SECTION 26 0500
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes general electrical requirements, and specific requirements on supports and electrical metering.

1.2 SUBMITTALS

- A. Product Data: Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of electrical support component used
- B. Shop Drawings:
 - 1. Descriptive information that states conformance to codes, recognized testing, or manufacturing standards.
 - 2. Manufacturer's name and catalog cuts listing type, model No., catalog No., materials, styles, finish.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- D. Review submittals for equipment furnished under other Sections prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.
- E. Contractor shall note any deviations from the requirements of the contract plans and specifications.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction such as Underwriters Laboratories, Inc., and marked for intended use.
- B. Perform Work in accordance with the current edition of the National Electrical Code (NEC) and the National Electrical Safety Code (NESC).
- C. Perform Work in accordance with local ordinances, codes and statutes.
- D. Work shown and specified in these Contract Documents establishes the minimum standard of construction. Comply with any additional requirements of the codes or local requirements.

1.4 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow:

1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Coordinate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Comply with the requirements of the NEC.
- D. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
- E. The electrical contractor shall coordinate and provide electrical conduit, boxes, devices for the data systems and the security / alarm systems. Refer to attached drawings for information and requirements for the special systems noted above. The contractor shall notify the A/E if there are conflicts or questions for the bidding or installation of the systems.

PART 2 PRODUCTS

2.1 SUPPORTING DEVICES

- A. Continuous Slot Channel (Strut) Steel Support Systems: Comply with Metal Framing Manufacturers Association Standard MFMA-3, factory-fabricated components for field assembly.
 1. Finishes:
 - a. Hot-dip galvanized: Hot-dip galvanized after fabrication and applied according to MFMA-3.
 - b. Electro-galvanized: Electroplated coating of zinc after fabrication and applied according to MFMA-3.
 - c. Pre-galvanized: Hot dip galvanized prior to fabrication applied according to MFMA-3.
 - d. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-3.
 - e. Epoxy Coatings: Strut and fittings shall be painted with water born epoxy according to MFMA-3.
 - f. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-3.
 2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 3. Fitting and Accessory Materials: Same as channels and angles [, except metal items may be stainless steel].
 4. Channel Dimensions: Selected for structural loading.
 5. Rated Strength: Selected to suit structural loading.
- B. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following requirements.

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel as required in Part 3 of this specification, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
3. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A325.
4. Toggle Bolts: All-steel springhead type.
5. Hanger Rods: Threaded steel.

2.2 CONDUCTORS IN VERTICAL CONDUIT

- A. Support for Conductors in Vertical Conduit: Provide a factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

2.3 EQUIPMENT ENCLOSURES

- A. Do not install equipment in a more severe environment than recommended by the equipment manufacturer. When not indicated, provide enclosures suitable for the environment in which they are located in accordance with NEMA Standard No. 250.

2.4 DEVICE CONNECTIONS

- A. Provide suitable lugs or connectors to accommodate line and load side conductors shown on the Drawings. Where available device connections are inadequate for the number and/or size of conductors required, provide bus extensions, adapter plates or power distribution blocks as required.

2.5 CONCRETE BASES AND HOUSEKEEPING PADS

- A. Concrete: Minimum of 2500-psi (20.7-MPa), 28-day compressive strength or as specified in Division 3 SECTION "Cast-in-Place Concrete."

2.6 TOUCHUP PAINT

- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
- B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Working clearance. Provide working clearance as required by the NEC.
- E. Dedicated space. Provide dedicated space for electrical equipment as required by the NEC.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp or Wet Locations and Outdoors: Provide hot dip galvanized steel slot (strut) channel, aluminum channel, or stainless steel (Type 304 or 316) channel. Provide stainless steel anchor bolts.
- B. Do not attach aluminum channel directly to concrete. Provide plastic spacers or coat surfaces in contact with concrete with epoxy paint.

3.3 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
 - 1. Do not fasten supports to piping, ceiling support wires, ductwork, mechanical equipment, or conduit.
 - 2. Install surface-mounted cabinets and panelboards with minimum of four anchors.
 - 3. Provide metal channel supports to stand cabinets and conduit one inch off wall in wet locations.
 - 4. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- D. Install 1/4-inch- (6-mm-) diameter or larger threaded steel hanger rods, unless otherwise indicated.

- E. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports. Do not use spring steel fasteners in damp, wet or corrosive locations.
- F. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- G. Simultaneously install vertical conductor supports with conductors.
- H. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- I. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- J. Securely fasten electrical items and their supports to the building structure per the following requirements, unless otherwise indicated. Perform fastening according to the following requirements unless other fastening methods are indicated. Verify with manufacturer the suitability of fasteners in subparagraphs below for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick. Fasteners which fracture or damage surfaces are not acceptable.
 1. Wood: Fasten with wood screws or screw-type nails.
 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
 3. New Concrete: Concrete inserts with machine screws and bolts.
 4. Existing Concrete: Expansion bolts.
 5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used.
 6. Steel: Welded threaded studs or spring-tension clamps on steel.
 7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
 8. Light Steel: Sheet-metal screws.
 9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 DEMOLITION

- A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

- C. Abandoned Work: Remove all abandoned wiring. In exposed locations, cut and remove buried raceway 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish. In concealed locations, cut raceways flush with surface. Plug or cap raceways.
- D. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.5 EXISTING ELECTRICAL WORK

- A. Verify that abandoned wiring and equipment serve only abandoned facilities.
- B. Disconnect existing electrical systems in walls, floors, and ceilings indicated for removal.
- C. Coordinate utility service outages and reconnections with Utility Company and Owner.
- D. Remove, relocate, and repair existing installations to accommodate new construction.
 - 1. Remove abandoned wiring to source of supply.
 - 2. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- E. Repair adjacent construction and finishes damaged during removal of existing electrical work.
- F. Maintain access to existing, active electrical installations.

3.6 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.7 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up painting:
 - 1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
 - 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
 - 3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.8 CLEANING AND PROTECTION

- A. On completion of installation, inspect and clean all electrical equipment and enclosures including panelboard, switchboard, transformer, motor control center, control panel and electrical enclosure interiors, light fixtures and lenses, outlet boxes, floor mounted devices, fittings, and wiring devices. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 26 0519
CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.2 SUBMITTALS

- A. Product Data: For conductors and cables [250 kcmil and larger] [over 600 volts], splices, and connectors.
- B. Shop Drawings:
 - 1. Descriptive information that states conformance to codes, recognized testing or manufacturing standards.
 - 2. Manufacturer's name and catalog cuts listing manufacturer, type, model No., catalog number.
 - 3. Electrical characteristics such as voltage and ampacity.
 - 4. Cable and Conductor material and insulation.
 - 5. NEC designation and plenum rating where applicable.

1.3 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Power and Lighting Circuits: Provide No. 12 AWG minimum conductors.
- B. 120-volt Control and Alarm Circuits: Provide No. 14 AWG minimum conductors.
- C. Conductor Material: Copper complying with ICEA S-95-658 /NEMA WC70 , solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.
- D. Service entrance and below grade feeders: Provide single copper conductors with the following characteristics:
 - 1. Insulated with 600-volt crosslinked polyethylene insulation.
 - 2. Comply with UL standard 584 for Type USE-2.
 - 3. Comply with UL standard 44 for Types RHW-2 and RHH.
 - 4. Comply with VW-1 flame test ratings.
 - 5. Comply with UL standard 44 for Gasoline and Oil Resistant II.

- E. Above grade and interior location feeders, branch circuits and field wired control circuits operating at 120 volts or greater: 600 Volt THWN or THHN insulation unless otherwise indicated.
- F. Milliamp Direct Current Circuits for Electronic Instrumentation: Each conductor shall be No. 18 AWG minimum, 7-strand copper with minimum 15-mil high-density polyethylene or equivalent insulation on each conductor. Cables shall be single twisted pairs or multiple twisted pairs each with a shield, and an overall jacket of 20-mil PVC minimum on single-pair cable and 45-mils PVC minimum on multi-pair cables. Shield shall be a laminated tape of aluminum and polyes-ter film. Provide a tinned copper drain wire in contact with the shield along the length of the cable. Provide Belden No. 8760 (18 gauge) or equal.
- G. MC cable shall not be used.
- H. NM and NMC cable shall not be used.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- B. Connections:
 - 1. Soldered connections are not acceptable.
 - 2. Push-in connectors are not acceptable.
 - 3. Indoor dry locations for No. 10 AWG wire and smaller: Provide solderless twist-on connectors listed to UL 486C - Ideal "Wire Nuts," 3M "Scotchlok," or equal.
 - 4. Indoor dry locations for No. 8 AWG wire and larger: Provide solderless connectors such as hydraulically crimped type or split bolts - Burndy, O.Z., Penn-Union or equal. Uninsulated joints shall be taped over with plastic tape, 3M "Scotch Brand" No. 33 Plus or equal, to provide an insulation value greater than or equal to that on the wire.
 - 5. Indoor dry locations in junction boxes or wireways: Power distribution blocks consisting of a single block of tin plated aluminum alloy mounted to an insulating base. The block shall be provided with conductor openings and set screws. Provide with insulated covers. The power distribution block shall be secured to the enclosure. Provide Ilsco PDB series or equal.
 - 6. Damp locations for No. 8 AWG wire and smaller: Provide solderless twist-on connections, factory pre-filled with silicone sealant listed to UL 486C and UL 486D – Ideal "WeatherProof" or equal.
 - 7. Wet and below grade locations (including below grade pullboxes and manholes) for No. 8 AWG and smaller: Provide solderless twist-on connections, factory pre-filled with silicone sealant listed to UL 486C and UL 486D for direct burial – Ideal "Underground" or equal.
 - 8. Wet and below grade locations (including below grade pullboxes and manholes) for No. 6 and larger: Provide connectors of one the following types:

- a. Multi-conductor connectors consisting of a single block of tin plated aluminum alloy covered with not less than 125 mils of dielectric plastisol. The block shall be provided with conductor openings and set screws. Each opening and set screw shall be provided with a removeable access plug. Do not install more than one conductor in any port. The assembly shall be listed to UL 486D for direct burial and submersible applications. Provide NSI Industries Polaris IPLW, ITW, ISPB, or ISPC series or equal.
- b. Gel splices consisting of a hydraulically crimped connector covered with a sealant gel and protective cover. The sealant gel shall seal upon contact to protect the splice from moisture. The gel shall be contained within a protective polypropylene enclosure. Splice shall be qualified to ANSI C119.1 for underground splicing and shall be UV resistant. Provide NSI Industries series WAGS, ESGS, ESGHS or equal.
- c. Poured splices consisting of a hydraulically crimped connector placed inside of a protective mold which is then filled with a waterproof polyurethane or resin. The polyurethane or resin shall be a liquid that when mixed that reacts to set into a solid, insulating material around the splice. The splice shall be listed to UL 486D for direct burial. Provide 3M series Scotchcast, Uraseal series ES, or equal.

2.3 TERMINATIONS

- A. Compression type solderless lugs shall be tin plated cast copper and U.L. listed for the application. Terminal lugs shall have a temperature rating that is equal or greater than that of the wire and terminal equipment.

PART 3 EXECUTION

3.1 CONDUCTOR DERATING

- A. Conductors shown on the drawings are based on no more than three current carrying conductors in a raceway. If the Contractor chooses to combine homeruns resulting in more than three current carrying conductors in a raceway then the Contractor shall apply the NEC derating factors for more than three current carrying conductors in a raceway

3.2 INSTALLATION

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

3.3 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Terminations: Terminate stranded wire at screw terminals with compression type lugs. Terminations made by looping stranded wire around a terminal screw are not acceptable.
- C. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

END OF SECTION

SECTION 26 0526
GROUNDING AND BONDING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.2 SUBMITTALS

- A. Product Data: For the following:
 - 1. Ground rods.
 - 2. Grounding conductors and cables
 - 3. Connector products
- B. Shop Drawings:
 - 1. Descriptive information which states conformance to codes, recognized testing or manufacturing standards.
 - 2. Manufacturer's name and catalog cuts listing type, model No., catalog No., finish, performance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 1. Comply with UL 467.
- B. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.
- C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 SECTION "Conductors and Cables".
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.

- D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- E. Grounding Electrode Conductors: Stranded cable.
- F. Bare Copper Conductors: Comply with the following:
 - 1. For Solid Conductors: ASTM B 3.
 - 2. For Assembly of Stranded Conductors: ASTM B 8.
- G. Protect exposed ground conductors in exterior locations to a height of 3'-0" minimum above grade with Schedule 40 PVC conduit or wood molding designed for the purpose.

2.2 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. The following type of connectors may be used:
 - 1. Bolted pressure-type.
 - 2. Compression-type connectors, terminals and lugs shall be tin plated copper.
 - 3. Exothermic-welded type, in kit form, and selected per manufacturers written instructions.

2.3 GROUNDING RODS

- A. Ground Rods: Copper-clad steel unless otherwise noted.
 - 1. Size: 3/4 by 120 inches (19 by 3000 mm) in diameter.
- B. Ground Rods: Sectional type; Copper-clad steel unless otherwise noted.
 - 1. Size: 3/4 by 120 inches (19 by 3000 mm) in diameter.

PART 3 EXECUTION

3.1 APPLICATION

- A. Use only copper conductors.
- B. In raceways, use insulated equipment grounding conductors.
- C. Direct Buried and Underground Connections: Use Exothermic-Welded Connections, except those at ground wells.
- D. Connections to Structural Steel: Use Exothermic-Welded connections or bolted pressure connections.
- E. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- F. Ground Rod Clamps at Ground Wells: Use bolted pressure clamps with at least two bolts.

3.2 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and circuits.

3.3 INSTALLATION

- A. Ground Rods: At exterior locations drive ground rods until tops are 12 inches (50 mm) below final grade, unless otherwise indicated. Where multiple ground rods are required to meet resistance requirements, install ground rods a minimum of 6 feet apart. Interconnect ground rods with grounding electrode conductors.
- B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- C. When grounding conductors are installed in metal conduit, bond conduit at each end to the grounding conductor.

3.4 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or tinned materials.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Coat and seal connections having dissimilar metals with bitumastic or similar waterproofing material to prevent future penetration of moisture to contact surfaces.
- B. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- C. If metallic raceways terminate at metal housings without an electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- D. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- E. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

- F. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.
- G. Twisting ground wires together as the only means of connection is not acceptable.

3.5 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing:
- B. Testing: Engage a qualified testing agency to perform the following field quality control testing:
- C. Testing: Perform the following field quality control testing:
 - 1. After installing grounding system but before permanent electrical circuitry has 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, and at ground wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the 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. Perform tests according to the [InterNational Electrical Testing Association] [IEEE Fall of Potential Method].
 - 3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
 - 4. Maximum ground resistance shall be as follows:
 - a. Equipment Rated 500 kVA and Less: 10 ohms.
 - b. Equipment Rated 500 to 1000 kVA: 5 ohms.
 - c. Equipment Rated More Than 1000 kVA: 3 ohms.
 - d. Substations and Pad-Mounted Switching Equipment: 5 ohms.
 - e. Manhole Grounds: 10 ohms.
 - 5. Excessive Ground Resistance: When the required ground resistance is not met, additional electrodes shall be provided to achieve the specified ground resistance. The additional electrodes shall be a minimum of 6 feet apart and meet the requirements of this specification.

END OF SECTION

SECTION 26 0533
RACEWAYS AND BOXES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 SUBMITTALS

- A. Product Data: For conduit, surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings:
 - 1. Descriptive information that states conformance to codes, recognized testing, or manufacturing standards.
 - 2. Manufacturer's name and catalog cuts listing type, model No., catalog No., materials, styles, finish.

1.3 QUALITY ASSURANCE

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

1.4 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Rigid Metal Conduit (RMC) - Steel: ANSI C80.1.
- B. Rigid Metal Conduit (RMC) - Aluminum: ANSI C80.5.
- C. Intermediate Metal Conduit (IMC): ANSI C80.6.
- D. Electrical Metallic Tubing (EMT) and Fittings: ANSI C80.3.
 - 1. Fittings: Compression type only. Hydraulically crimped or set screw connections are not acceptable.
- E. Flexible Metal Conduit (FMC): Zinc-coated steel.

- F. Liquidtight Flexible Metal Conduit (LFMC): Flexible steel conduit with oil-proof PVC jacket.
- G. Flexible Couplings (Hazardous Location): Couplings for connection to vibrating equipment shall be stainless steel. Couplings shall be rated Class I Division 1 & 2 Groups A,B,C,D; Class II Division 1 & 2 Groups E,F,G; Class III; and watertight.
- H. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.2 SURFACE RACEWAYS

- A. General: Raceway shall be compact, shaped like molding to blend with wall and ceiling construction. Provide surface raceway systems complete with fittings, boxes, adapters for use with existing boxes, and all accessories necessary for a complete and finished installation. Boxes shall be suitable for surface mounting at locations shown. Provide the manufacturers standard mounting straps, assemblies, covers, elbows, couplings, support clips, tee's and box connectors.

2.3 BOXES AND ENCLOSURES

- A. Enclosure ratings: NEMA 3R.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
- D. Junction and Pull Boxes:
 - 1. Boxes less than 100 cubic inches: NEMA OS 1.
 - 2. Screw covers shall be used unless otherwise indicated on drawings.

2.4 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard gray paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

2.5 WEATHERPROOF HUBS

- A. Provide weatherproof hubs for any conduit entry on the top of all enclosures located in damp or wet locations.

PART 3 EXECUTION

3.1 RACEWAY APPLICATION

- A. General: Use of any of the conduit types in accordance with NEC, Articles 342 through 360, is acceptable with the following exceptions.
 - 1. EMT shall not be installed in con-crete, in wet locations as defined by NEC, in wet locations as noted on the Drawings, or in direct contact with the earth.
 - 2. Nonmetallic conduit shall only be installed underground or encased within poured concrete structures. Nonmetallic conduit shall be adapted to the appropriate type

of metal conduit before it emerges from concealment. All elbows shall be metallic.

- B. Outdoors, damp:
 - 1. Exposed: RMC or IMC.
 - 2. Concealed: RMC or IMC.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 4. Boxes and Enclosures: NEMA 3R [3R/12] [4] [4X] unless otherwise indicated.
- C. Outdoors, wet:
 - 1. Exposed: RMC or IMC.
 - 2. Concealed: RMC or IMC.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 4. Boxes and Enclosures: NEMA 3R [3R/12] [4] [4X] unless otherwise indicated.
- D. Indoors, dry:
 - 1. Exposed: EMT [IMC] [RMC].
 - 2. Concealed: EMT.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC.
 - 4. Connections to light fixtures above accessible ceilings: FMC.
 - 5. Boxes and Enclosures: Type 1 [12] unless otherwise indicated.
- E. Conduit Penetrations: All conduits penetrating through floor slabs, concrete walls or grade shall be galvanized rigid steel with factory PVC coating or wrapped with PVC tape. Coating shall extend 2 inches minimum above slab or finished grade. PVC tape shall be 3M Scotchrap 50 (10 mils) or equal. Conduit shall be cleaned and painted with 3M Scotchrap pipe primer and tape shall be half-lapped to provide a minimum of 20 mils coating at any point on the conduit. Adapters from buried PVC conduit to galvanized rigid steel conduit shall be wrapped with PVC tape after assembly.
- F. Minimum Raceway Size: 3/4-inch trade size (DN 21).
- G. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
 - 2. EMT: Use compression fittings only. Set screw fittings are not acceptable.
- H. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- I. Do not install aluminum conduits embedded in or in contact with concrete or earth.

3.2 INSTALLATION

- A. Keep raceways at least 8 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- B. Complete raceway installation before starting conductor installation.

- C. Support raceways as specified in Division 26 SECTION "Basic Electrical Materials and Methods".
- D. Install temporary closures to prevent foreign matter from entering raceways.
- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
- F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- G. Conceal conduit within finished walls, ceilings, and floors, unless otherwise indicated.
 - 1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
 - 2. Conduits in unfinished areas associated with exposed equipment, and raceways on open ceiling construction, may be installed exposed.
- H. Install conduits exposed and boxes surface mounted unless otherwise specified or shown.
- I. RMC and IMC: Support and securely fasten in place at intervals not to exceed 10'-0".
- J. EMT: Support and securely fasten in place at intervals not to exceed 5'-0".
- K. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
 - 1. Run parallel or banked raceways together on common supports.
 - 2. When bending parallel conduits, all conduit bends shall have the same radius or concentric bends.
 - 3. Raceway installation shall not obstruct light fixtures, electrical equipment and mechanical assemblies.
- L. Join raceways with fittings designed and approved for that purpose and make joints tight.
 - 1. Use insulating bushings to protect conductors.
- M. Terminations:
 - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- N. Stub-up connections: Stub-up conduits a minimum of 2" above floor or equipment pad of free standing equipment. Provide bushings on metallic conduit, and provide caps for spare conduits.
- O. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
- P. Temperature:

1. Conduits exposed to changes in temperature or attached to structures that may expand or contract shall be provided with expansion fittings.
 2. Nonmetallic or PVC coated conduits shall not be installed in areas where the temperature may exceed 122 degrees F for extended periods of time.
- Q. Provide raceway expansion joints where raceway crosses building and structural expansion joints.

3.3 PENETRATION SLEEVES

- A. Sleeves: Furnish sleeves for conduit passing through concrete walls, partitions, beams, floors and roof while same are under construction. A conduit sleeve shall be one size larger than the size of conduit which it serves except where sealing bushings are used in sleeves through walls below grade. Sleeves are not required for conduits installed before the wall, partition, floor, or roof is constructed.

3.4 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.5 CLEANING

- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes. Match factory finish with same material and color.

END OF SECTION

SECTION 26 0923
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes the lighting control devices for systems 600 volts and below such as time or photoelectric switches, occupancy sensors or lighting contactors.

1.2 SUBMITTALS

A. Shop Drawings:

1. Descriptive information that states conformance to codes, recognized testing, or manufacturing standards.
2. Manufacturer's name and catalog cuts listing type, model No., catalog No., materials, styles, finish and electrical ratings.
3. Lighting control panel drawings, include the following for each panel provided:
 - a. U.L. certification.
 - b. Markings as required by the NEC Article 409.
 - c. Control schematic diagram.
 - d. Control panel door layout and inner panel layout drawings.
 - e. Bill of material.
 - f. For all equipment listed in the bill of material submit the manufacturer's name and catalog cuts listing type, model No., catalog No., materials, styles, finish and electrical ratings.

B. Operations and Maintenance Manuals shall include the following information:

1. All information submitted with shop drawings.
2. Manufacturer's maintenance and repair instructions.
3. Manufacturer's instructions provided with equipment.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Each type of lighting control device shall be from a single manufacturer, and shall be of the same style and model number.
- B. Lighting control panels shall be manufactured by a U.L. certified panelbuilder and conform to the requirements of U.L. 508A.

1.4 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 PRODUCTS

2.1 SWITCH-BOX OCCUPANCY SENSORS

- A. Description: PIR type with integral power-switching contacts rated for 800 W at 120-V ac, suitable for incandescent light fixtures, fluorescent light fixtures with magnetic or electronic ballasts, or 1/6-hp motors; and rated for 1000 W at 277-V ac, suitable for incandescent light fixtures, fluorescent light fixtures with magnetic or electronic ballasts, or 1/3-hp motors, minimum.
1. Include ground wire.
 2. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (215 to 2150 lx); keeps lighting off when selected lighting level is present.

2.2 INDOOR OCCUPANCY SENSORS

- A. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 6. Bypass Switch: Override the on function in case of sensor failure.
 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (215 to 2150 lx); keeps lighting off when selected lighting level is present.
- B. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
1. Detector Sensitivity: Detect occurrences of 6-inch (150-mm) minimum movement of any portion of a human body that presents a target of at least 36 sq. in. (232 sq. cm).
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27 m) when mounted on a 10-foot- (3-m-) high ceiling.
- C. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
1. Detector Sensitivity: Detect a person of average size and weight moving at least 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on an 8-foot- (2.4-m-) high ceiling.
 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).
- D. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch (150-mm) minimum movement of any portion of a human body that presents a target of at least 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving at least 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

PART 3 EXECUTION

3.1 WIRING INSTALLATION

- A. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- B. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.2 FIELD QUALITY CONTROL

- A. Perform the following operational tests and inspections:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for proper operation.
 - 2. Operational Test: Verify actuation of each sensor and adjust time delays.
- B. Remove and replace lighting control devices where operational tests indicate that they do not comply with specified requirements.

3.3 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

3.4 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

END OF SECTION

SECTION 26 2726
WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes wiring devices for systems 600 volts and below, which includes receptacles, switches and similar equipment.

1.2 SUBMITTALS

- A. Shop Drawings:
1. Descriptive information that states conformance to codes, recognized testing, or manufacturing standards.
 2. Manufacturer's name and catalog cuts listing type, model No., catalog No., materials, styles, finish and electrical ratings.
- B. Operations and Maintenance Manuals shall include the following information:
1. All information submitted with shop drawings.
 2. Manufacturer's maintenance and repair instructions.
 3. Manufacturers written instructions provided with the equipment.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Each type of wiring device shall be from a single manufacturer, and shall be of the same style and model number.

PART 2 PRODUCTS

2.1 FINISHES

- A. Color for all device face plates:
1. Wiring Devices Connected to Normal Power System: Verify color and material with architect, unless otherwise indicated on drawings or required by NFPA 70.
 2. Isolated-Ground Receptacles: Orange.
 3. Wiring Devices Connected to Emergency Power System: [Red] <Insert color>.

2.2 RECEPTACLES

- A. 20 Ampere, 125-volt Straight-Blade-Type Receptacles:
1. Comply with NEMA WD 1, NEMA WD 6, FEDERAL SPECIFICATION W-C-596G, and UL 498.
 2. 20 Ampere Grounding type duplex receptacles shall be Specification Grade, NEMA 5-20R, Cooper No. 5352, Leviton No. 5352, Hubbell No. HBL 5352 Series or equal.

3. 20 Ampere Grounding type single receptacles shall be Specification Grade, NEMA 5-20R, Cooper No. 5351, Leviton No. 5361, Hubbell No. 5361, or equal.
- B. Ground Fault Circuit Interrupting (GFCI) 20 Ampere, 125-volt Straight-Blade-Type Receptacles:
1. Comply with NEMA WD 1, NEMA WD 6, FEDERAL SPECIFICATION W-C-596G, UL 498 and UL 943.
 2. GFCI 20 Ampere Grounding type duplex receptacles shall be Specification Grade, NEMA 5-20R, Cooper No. XGF20, Leviton No. 6898, Hubbell No. GF5362 Series or equal.
 3. Unless otherwise indicated, feed-through feature shall not be used to protect downstream receptacles.
- C. Isolated Ground (IG) 20 Ampere, 125-volt Straight-Blade-Type Receptacles:
1. Comply with NEMA WD 1, NEMA WD 6, FEDERAL SPECIFICATION W-C-596G, and UL 498.
 2. 20 Ampere Isolated Ground type duplex receptacles shall be Specification Grade, NEMA 5-20R, Cooper No. IG5362, Leviton No. 5362IG, Hubbell No. HBL IG5362 Series or equal.
- D. Faceplates or Covers for 20 Ampere Receptacles:
1. Faceplates for surface-mounted boxes in exposed conduit work shall be galvanized steel.
 2. Faceplates for flush-mounted duplex receptacles shall be stainless steel, Cooper 93000 series, Leviton No. 84000 series, Hubbell No. S8 Series, or equal.
 3. Faceplates for flush-mounted single receptacles shall be stainless steel, Cooper 93000 series, Leviton No. 84000 series, Hubbell No. S7 Series, or equal.
 4. Faceplates for flush-mounted GFCI and TVSS receptacles shall be stainless steel, Cooper 93000 series, Leviton No. 84000 series, Hubbell No. S26 Series, or equal.
 5. Faceplates for weatherproof single receptacles shall be metal, heavy duty, self-closing, Cooper 1990 or 992, Leviton No. 4925-2, Hubbell No. 7420 or equal.
 6. Faceplates for weatherproof duplex receptacles shall be metal, heavy duty, Red Dot No. CK5GV, Cooper No. 994 or 989, Leviton 4926 or 4970, Hubbell HBL 5205W0 or HBL 5206W0, or equal.
 7. Faceplates for weatherproof ground fault interrupting duplex receptacles shall be metal, heavy duty, self-closing, Cooper No. 966 or 1966, Leviton 6196-FS or 6196-VFS, Hubbell No. WP26, or WPFS26 or equal.
 8. Weatherproof While In Use Covers: Where indicated and at all wet location receptacles, provide weatherproof while in use covers in accordance with NEC 406.8. Covers shall be die cast aluminum, heavy duty, self-closing, rated NEMA 3R, and be lockable. Provide Thomas & Betts/Red Dot "Code Keeper" (metal) series, Intermatic "Guardian" WP1000MC (metal) series, or equal.
- E. 30 Ampere and Larger Straight Blade Receptacles:
1. 30-ampere, 125-volt, grounded, 2-pole, 3-wire, NEMA 5-30R: Cooper No. 1233, Leviton No. 5371, Hubbell No. HBL9308, or equal. Provide with stainless steel faceplate.

2. 30-ampere, 125/250-volt, ungrounded, 3-pole, 3-wire, NEMA 10-30R: Cooper No. 38B, Leviton No. 5207, Hubbell No. HBL9350, or equal. Provide with stainless steel faceplate.
 3. 30-ampere, 125/250-volt, grounded, 3-pole, 4-wire, NEMA 14-30R: Cooper No. 1257, Leviton No. 278, Hubbell No. HBL9430A, or equal. Provide with stainless steel faceplate.
 4. 50-ampere, 250-volt, grounded, 2-pole, 3-wire, NEMA 6--50R: Cooper No. 1254, Leviton No. 5374, Hubbell No. HBL9367, or equal. Provide with stainless steel faceplate.
 5. 50-ampere, 125/250-volt, ungrounded, 3-pole, 3-wire, NEMA 10-50R: Cooper No. 32B, Leviton 5206, Hubbell No. HBL7962, or equal. Provide with stainless steel faceplate.
 6. 50-ampere, 125/250-volt, grounded, 3-pole, 4-wire, NEMA 14-50R: Cooper No. 1258, Leviton No. 279, Hubbell No. HBL9450A, or equal. Provide with stainless steel faceplate.
- F. Specialty Receptacles:
1. Industrial Heavy-Duty Pin and Sleeve Devices: Comply with IEC 309-1 and IEC 309-2.
 2. Hazardous (Classified) Location Receptacles: Comply with NEMA FB 11.

2.3 SWITCHES

- A. 20 Ampere, 120- to 277-volt, Toggle Type Snap Switch:
1. Comply with NEMA WD 1, FEDERAL SPECIFICATION W-C-896F and UL 20.
 2. Single pole switches shall be Specification Grade, Cooper No. 2221, Leviton No. 1221, Hubbell No. HBL1221 Series or equal.
 3. Double pole switches shall be Specification Grade, Cooper No. 2222, Leviton No. 1222, Hubbell No. HBL1222 Series or equal.
 4. Three-way switches shall be Specification Grade, Cooper No. 2223, Leviton No. 1223, Hubbell No. HBL1223 Series or equal.
 5. Four-way switches shall be Specification Grade, Cooper No. 2224, Leviton No. 1224, Hubbell No. HBL1224 Series or equal.
 6. Key switches (utilizing a flat metal blade type key) shall be Specification Grade, Cooper No. 2221L, Leviton No. 1221L, Hubbell No. HBL1221L Series or equal.
 7. Pilot light switches (toggle illuminated when switch is "On") shall be Specification Grade, Cooper No. 2221PL, Leviton No. 1221PL, Hubbell No. HBL1221PL Series or equal.
- B. Faceplates or covers for Toggle Type Snap Switches:
1. Faceplates for surface-mounted switches in exposed conduit work shall be galvanized steel.
 2. Faceplates for flush-mounted switches shall be stainless steel, Cooper No. 93070 series, Leviton No. 84000, Hubbell No. S Series, or equal.
 3. Faceplates for weatherproof switches shall be enclosed with external lever, Red Dot No. CCT series, Leviton 1432 or equal
- C. Dimmer Switches, Incandescent Lighting Control:

1. Comply with NEMA WD 1, UL 20, and UL 1472
2. Solid-state units with integral audible frequency and EMI/RFI filters.
3. Integral mechanical air-gap switch to totally disconnect power from the load when in the "off" position.
4. Continuously variable, full range control of light intensity. Following power outage, the lighting will come back on at the same intensity.
5. Rating: 120-volts, 60 Hz, 2000 [] watts for use on a 20 ampere circuit.
6. Slider Type Control, Single Pole, 120-volts: Lutron N-2000, or equal.
7. Rotary Knob Type Control, Single Pole, 120-volts: Lutron C-2000, Leviton 62000, or equal.
8. Provide unit complete with non-metallic, white [other color] faceplate.

2.4 MULTIOUTLET ASSEMBLIES

- A. General: Provide a multi-outlet assembly consisting of a surface metal raceway with a factory assembled receptacle harness. Assembly shall be complete with fittings, boxes, adapters, and all accessories necessary for a complete and finished installation. Install in accordance with NEC Article 380.
- B. Material: Provide raceway constructed of steel. [Finish shall be manufacturer's standard paint finish, [buff] [gray] [ivory] in color.] [Paint raceway to match the surface on which it is mounted. Receptacles shall not be painted.]
- C. Supports: Join sections with couplings and securely fasten to wall at intervals not exceeding 30 inches. Fasteners shall be flat head type to avoid abrading wire insulation.
- D. Receptacles: Provide single, NEMA 5-20R receptacles mounted at 12-inch [6-inch] [18-inch] intervals. Provide a [single circuit, 3-wire] [two circuit (receptacles wired alternately), 4-wire] #12 AWG wiring harness. Provide a ground clamp installed in each section of raceway and connected to the grounding conductor.

2.5 TELEPHONE/POWER SERVICE POLES

- A. Description: All power poles indicated on the drawings shall be provided by the owner and installed by the contractor. Coordinate with supplier.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies level, plumb, and square with building lines.
- B. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- C. Remove wall plates and protect devices and assemblies during painting.
- D. GFCI receptacle wiring. Each location shown as a GFCI receptacle shall have a GFCI receptacle at that location. Each GFCI receptacle shall be wired to the line side

terminals. Unless specifically noted, no wiring shall be connected to the load terminals of the GFCI receptacle.

- E. Outlet box: Provide a dedicated outlet box for the dimmer switch. Do not gang dimmer switches in multi-gang outlet boxes.
- F. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' written instructions.

3.2 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
 - 2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION

SECTION 26 2816
SAFETY SWITCHES AND ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes safety switches (also known as disconnect switches, distribution equipment switches, or disconnects) and enclosed circuit breakers.

1.2 SUBMITTALS

- A. Product Data: For safety switches and enclosed circuit breakers.
- B. Shop Drawings: For each type of safety switch, enclosed circuit breaker, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 - 1. Enclosure types, ratings and outline drawings.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current rating.
 - 4. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 5. Fuse ratings, type, and time-current coordination curves for each fuse.
- C. Operation and Maintenance Data: For safety switches and enclosed circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:
 - 1. Manufacturer's written instructions for testing and adjusting safety switches and circuit breakers.
 - 2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Safety switches and all components shall be designed, manufactured and tested in accordance with the latest applicable standards:
 - 1. NEMA KS-1
 - 2. UL 98
- C. Fuses shall be UL listed and conform to NEMA FU1. [All fuses over 600A shall be dual element Class "L" Bussmann Hi-Caps with all fuses 600A and smaller Class "R" Bussmann Fusetrons, unless otherwise noted.]

1.4 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Quantity equal to 20 percent of each fuse type and size, but no fewer than 3 of each type and size.

PART 2 PRODUCTS

2.1 SAFETY SWITCHES

- A. Fusible and Non-Fusible Safety Switches, 1200 amp and smaller: Provide safety switches, Heavy Duty Type HD conforming to NEMA KS-1 and Federal Specification W-S-865C, 600-Volts, horsepower rated for motors as required. Provide number of poles and ampacity as noted or required by Code. Switches shall be fused where indicated, or where required by UL labeling or listing of equipment served. Handle shall have provisions for padlocking in the off position and the door shall have provisions for padlocking closed.
- B. All safety switches in publicly accessible spaces shall have provisions for padlocking in the on position or if indicated on the plans.
- C. Switch blades shall be visible when the switch is in the "Off" position and the door is open.
- D. Provide factory installed neutral assembly for switches installed on circuits with a neutral.
- E. Provide factory installed ground lug kits.
- F. Safety Switches shall have defeatable door interlocks that prevent the door from opening when the handle is in the ON position. Defeater mechanism shall be accessible.
- G. Fusible switches 30-amp through 600-amperes shall be furnished with rejection type Class "R" fuse clips and 601-amp through 1200-amperes shall be furnished with Class "L" fuse clips unless otherwise indicated.
- H. The following factory modifications are to be included:
 - 1. Factory installed auxiliary contacts

2.2 FUSES FOR SWITCHES

- A. Interrupting Capacity: Provide fuses with interrupting capacities equal to or greater than the available fault currents shown on the Drawings.

- B. Type and Speed: Provide fuses of various types and of the appropriate speeds to provide selective coordination [in accordance with the coordination study]. Submit time-current coordination curves for each fuse.
- C. Labeling: Provide a nameplate or a manufacturer's preprinted label attached adjacent to each fuse or set of fuses. Label shall indicate manufacturer's name, manufacturer's catalog number, UL class, voltage rating, current rating, and speed.
- D. Manufacturer: All fuses provided shall be of the same manufacturer.

2.3 ENCLOSED CIRCUIT BREAKERS

- A. Enclosed Circuit Breakers: Provide enclosures for thermal magnetic circuit breakers conforming to NEMA 250 and UL 489. Handle shall have provisions for padlocking in the off position and the door shall have provisions for padlocking closed.
- B. Except for NEMA 1 units, all other enclosed circuit breakers shall have an exterior operating handle. Units with only covers or doors over breaker handles are not acceptable.
- C. All enclosed circuit breakers in publicly accessible spaces shall have provisions for padlocking in the on position or if indicated on the plans.
- D. Provide factory installed neutral assembly for enclosed circuit breakers installed on circuits with a neutral.
- E. Provide factory installed ground lug kits.
- F. Circuit breakers: Provide circuit breakers with the current and voltage ratings as shown. Circuit breakers shall be UL listed and conform to NEMA AB1, UL 489, and Federal Specification W-C-375B/GEN.
- G. Interrupting Capacity: Provide circuit breakers with interrupting capacities equal to or greater than the available fault currents shown on the Drawings. Minimum allowable interrupting capacity of 120- and 240-volt circuit breakers is 10,000 RMS symmetrical amperes. Minimum allowable interrupting capacity of 277- and 480-volt circuit breakers is 14,000 RMS symmetrical amperes.
- H. Series Rating: Do not apply circuit breakers at series interrupting ratings. Each breaker shall be capable of interrupting the fault current available at that location in the distribution system without the assistance of any other device(s).
- I. Adjustable Circuit Breakers: Provide with a sealable cover over the adjust-ing means, except for adjustable magnetic trips on thermal magnetic breakers which do not require covers.
- J. Molded Case thermal Magnetic Circuit Breakers: Provide circuit breakers with overcenter toggle type mechanisms for quick make and break, trip free operation. Breakers shall provide thermal overload and instantaneous magnetic trip for each pole of the unit. Breakers larger than 100 amperes shall have adjust-able magnetic trip. Multiple pole breakers shall have one common operating handle.
- K. Ground Fault Trip for Thermal Magnetic Circuit Breakers: Where shown on the Drawings, provide a ground fault sensing unit and a shunt trip circuit breaker. Ground

fault sensing unit shall be a solid state device and shall conform to UL 1053. Sensing unit shall have adjustable pickup current and time delay. The unit shall have a test button and an indicator to show when the unit has tripped. Provide any current transformers required by the unit.

- L. Solid State Trip Circuit Breakers: Provide 80 percent rated circuit breakers. Provide circuit breakers with an overcenter toggle type mechanism or a two step, stored energy mechanism. Stored energy mechanisms shall be manually operated [electrically operated]. The mechanism shall provide quick make and break, trip free operation. Multiple pole breakers shall have one common operating handle. The integral trip unit shall be independent of any external power source. Provide indicators to show when the breaker has tripped and the protective feature which initiated the trip. Sensing units shall sense RMS components.
- M. Accessories: Provide auxiliary contacts, shunt tripping mechanisms, handle locking devices, lugs or terminals, and any other accessory as specified, indicated on the Drawings, or where required to perform the functions indicated.

2.4 DOUBLE THROW SAFETY SWITCHES

- A. Double Throw Fusible and Non-Fusible Safety Switches: Provide double throw safety switches conforming to NEMA KS-1 and Federal Specification W-S-865C, 600-Volts, horsepower rated for motors as required. Provide number of poles and ampacity as noted or required by Code. Switches shall be fused where indicated, or where required by UL labeling or listing of equipment served.
- B. Safety switch operator shall be padlockable in each of the three positions and the door shall be padlockable closed.
- C. Switch blades shall be visible when the switch is in the "Off" position and the door is open.
- D. Provide factory installed neutral assembly for switches installed on circuits with a neutral.
- E. Provide factory installed ground lug kits.
- F. Fusible switches shall be furnished with rejection type Class "R" fuse clips.
- G. The following factory modifications are to be included:
 - 1. Factory installed auxiliary contacts

PART 3 EXECUTION

3.1 INSTALLATION

- A. Provide enclosures rated for environmental conditions at installed location.
 - 1. Outdoors, damp or wet: NEMA 250, Type 3R/12 [3R] [4X, stainless steel].
 - 2. Indoors, dry: NEMA 250, Type 1.
 - 3. Indoors, damp or wet: NEMA 250, Type 3R/12 [3R] [4X, stainless steel].
 - 4. Kitchen Areas, surface mounted: NEMA 250, Type 3R/12 [4X, stainless steel].

5. Corrosive locations: NEMA 250, Type 4X, stainless steel.
 6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7D with breather and drain [and dual rated NEMA type 4X].
- B. Mount plumb and rigid without distortion of enclosure.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 SECTION "Electrical Identification".
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 SECTION "Electrical Identification".

3.3 FUSE APPLICATIONS

- A. Service Entrance: Class RK1 time delay [Class L time delay].
- B. Feeders: Class RK1, fast acting.
- C. Motor Branch Circuits: Class RK5 time delay.
- D. Spare Fuses: For each fuse of a particular amperage, voltage, type, and speed installed, provide 20 percent spare fuses, three minimum.

3.4 ADJUSTING

- A. Set field-adjustable circuit-breaker trip ranges.

3.5 CLEANING

- A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.
- B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION

SECTION 26 5000
LIGHTING

PART 1 GENERAL

1.1 GENERAL

- A. This Section includes lighting equipment.

1.2 SUBMITTALS

- A. Shop Drawings: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
1. Physical description of lighting fixture including dimensions, weights, and field assembly requirements.
 2. Wiring diagrams.
 3. Emergency lighting units including battery and charger.
 4. Ballast.
 5. Energy-efficiency data.
 6. Rated life, initial and mean lumen output, color temperature, CRI rating and input watt data for lamps. Document low mercury rating where indicated.
 7. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

1.3 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies. All lenses, covers and diffusers requiring removal for servicing shall be accessible and serviceable.

1.4 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps: 1 for every 10 of each type and rating installed. Furnish at least one of each type.
 2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 3. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 4. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. The lighting fixture schedule is a guide to indicate the general type required. Equivalent lighting fixtures by other manufacturers may be submitted for review unless the fixture is indicated as “no substitutions”. The lighting fixtures have been selected on the basis of such factors as performance data, suitability for the particular application, quality of construction, materials of construction, unit cost, maintainability, reputation of the manufacturer, aesthetics, compatibility with surrounding architecture and/or interior design and color schemes, etc. Proposed equivalent fixtures shall be comparable in all respects.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Comply with UL 1598.
- B. Metal Parts: Free of burrs and sharp corners and edges.
- C. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to facilitate relamping. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- E. Plastic Diffusers, Covers, and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
 - b. UV stabilized.
- F. Lens: All fixtures using metal halide or quartz halogen lamps shall have a lens which will contain all fragments from a lamp failure.
- G. Refer to Light Fixture Schedule for requirements and fixture types.

2.3 EXIT SIGNS

- A. General: Internally lighted sign with battery back up. Comply with UL 924.
- B. Internally Lighted Signs: Lamps shall be LEDs, 70,000 hours minimum rated lamp life.
- C. Battery and charger: Integral automatic charger in a self-contained power pack.
 - 1. Battery: Sealed, maintenance-free type.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored,

relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. Provide LED status indicator light which indicates power on and charging status.

2.4 EMERGENCY LIGHTING UNITS

- A. General: Battery-powered emergency lights shall provide emergency light automatically and instantaneously upon failure or interruption of the normal electric power.
- B. Battery: Emergency power source shall be a rechargeable, maintenance-free gel cell battery with published rated life expectancy of at least 5 years. Battery capacity shall be sufficient to provide lighting for a period of 90 minutes minimum.
- C. Lamps: Provide a unit with two lighting fixture heads, complete with lamps.
- D. Controls: Provide solid state controls including a low voltage disconnect and a charging circuit compatible with the battery furnished. Provide a test switch and "ready" indicating light.
- E. Time Delay Feature: Where indicated, provide a time delay feature integral with the unit. Lamps shall remain energized for at least 10 minutes after power is restored.
- F. Accessories: Unit shall be equipped with suitable wire guard where indicated.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Coordinate support for lighting fixtures in or on grid-type suspended ceilings with ceiling installer.
- C. Suspended Lighting Fixture Support:
 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 2. Provide seismic bracing for pendants of all lengths as required.
- D. Adjust aimable lighting fixtures to provide required light intensities.
- E. Remote mounted emergency ballast shall be installed indoors above accessible ceiling where available. If unit is mounted exposed, install in NEMA 1 steel enclosure. The remote status indicator shall and test switch shall be wall mounted within 10 feet of the remote ballast and be readily accessible.

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

END OF SECTION