SECTION 23 07 13
DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Glass Fiber Flexible Duct Wrap Insulation

B. Flexible Elastomeric Cellular Insulation

1.02 RELATED REQUIREMENTS

A. Section 22 05 53 - Identification for Plumbing Piping and Equipment.

B. Section 23 31 00 - HVAC Ductwork and Casings:

1.03 REFERENCE STANDARDS

A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM C553 - Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

D. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation.

E. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

G. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

H. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

I. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association.

J. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.

K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.

L. Reference standards shall be the latest revision as accepted by the local Authority Having Jurisdiction.

1.04 SUBMITTALS

A. Product Data: Provide data for all materials.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on-site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Do not store excess material in the building. Provide secure dry storage on-site, to store material.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION INSTALLED INSIDE BUILDINGS

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.02 MANUFACTURERS

A. Knauf Fiber Glass

B. Johns Manville Corporation

C. Owens Corning Corp

D. CertainTeed Corporation

E. Pittsburgh Corning Corporation

F. Armacell International

G. Approved equal.

2.03 GLASS FIBER, FLEXIBLE

A. Insulation: ASTM C553; flexible, noncombustible blanket.
1. 'K' value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
2. Maximum Service Temperature: 450 degrees F.
3. Maximum Water Vapor Sorption: 5.0% by weight.

B. Usage: HVAC Air Distribution Systems Ductwork - Interior - Medium to Low Temperatures.

C. Vapor Barrier Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber-based adhesive.

E. Tie Wire: Annealed steel, 16 gage.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that ductwork pressurization has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards; have a copy on site for reference. Employ only skilled tradesmen specializing in this kind of work.

C. Insulated ductwork conveying air, below ambient temperature:
1. Provide insulation with vapor barrier jackets.
2. Finish with tape and vapor barrier jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

D. Insulated ductwork conveying air above ambient temperature:
   1. Provide with standard vapor barrier jacket.
   2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

E. The insulation thickness, layers, and installation method shall be as recommended by the manufacturer to maintain the fire integrity and performance rating. Insulation shall be continuous through all sleeves and openings.

3.03 SCHEDULES

A. Provide thickness of insulation to meet or exceed Washington State Energy Code and or local codes whichever are more stringent.

B. Special Requirements - DUCT WRAP.
   1. Wrap all of the following ductwork:
      a. Supply/Exhaust ductwork in the attic
      b. Plenums.
      c. Outside air and exhaust air ductwork from damper to building opening, louver, or hood. Insulation R-value is to match building envelope insulation R-value regardless of location, per the requirements of the Washington State Energy Code.
      d. Insulation for the outside/exhaust air for the heat pumps.
   2. Duct wrap shall not be used in the following applications:
      a. In conditioned spaces, do not wrap ductwork exposed to view within a zone that serves that zone.

C. Provide insulation thicknesses per Washington State Energy Code as a minimum.

END OF SECTION

SECTION 23 08 00
MECHANICAL COMMISSIONING

PART 1 GENERAL

1.01 SUMMARY

A. This section covers the Mechanical Contractor's responsibilities, and that of his subcontractors, for commissioning; each subcontractor or installer is responsible for the installation of a particular system or equipment item to be commissioned, and is responsible for the commissioning activities relating to that system or equipment item.

B. The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:
   1. Control system.
   2. Major and minor equipment items.
   3. Air Handling systems

C. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.02 REFERENCE STANDARDS

A. ASHRAE Guideline 1 - The HVAC Commissioning Process; 1996

1.03 SUBMITTALS

A. DRAFT Prefunctional Checklists and Functional Test Procedures for Control System: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled.

B. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval.

C. HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
   1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.
   2. Full as-built set of control drawings.
   3. Maintenance instructions.
   4. Control equipment component submittals, parts lists, etc.
   5. Warranty requirements.
   6. Copies of all checkout tests and calibrations.

D. Project Record Documents:
   1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
   2. Show actual locations of all sensors on project record drawings.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

PART 2 PRODUCTS: NOT USED

PART 3 EXECUTION

3.01 PREPARATION

A. Develop the Prefunctional Checklists and Functional Test Procedures.

B. Prepare a preliminary schedule for HVAC testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion; update the schedule as it changes.

C. Notify the Owner's Representative when piping and duct systems testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur.

D. Put all equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.
   1. Include cost of sheaves and belts that may be required for testing, adjusting, and balancing.

E. Provide test holes in ducts and plenums where needed to allow air measurements and air balancing; close with an approved plug.

F. Provide temperature and pressure taps in accordance with the contract documents.
   1. Provide a pressure/temperature plug at each water sensor that is an input point to the control system.

3.02 INSPECTING AND TESTING - GENERAL

A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.

B. Perform the Functional Tests directed by the Owner's Representative for each item of equipment or other assembly to be commissioned.

C. Valve/Damper Stroke Setup and Check:
   1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
   2. Set pump/fan to normal operating mode.
   3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
   4. Command valve/damper open; verify position is full open and adjust output signal as required.
   5. Command valve/damper to a few intermediate positions.
   6. If actual valve/damper position does not reasonably correspond, replace actuator.

D. Isolation Valve or Coil Valve Leak Check:
   1. With full pressure in the system, command valve closed.
   2. Use an ultra-sonic flow meter to detect flow or leakage.

E. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.03 TAB COORDINATION

A. TAB: Testing, adjusting, and balancing.

B. Coordinate commissioning schedule with TAB schedule.

C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.

D. Provide all necessary unique instruments and instruct the TAB technicians in their use. This includes handheld control system interface for setting terminal unit boxes, etc.

E. Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Owner's Representative prior to starting TAB.

F. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.

3.04 CONTROL SYSTEM FUNCTIONAL TESTING

A. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of the Contract Documents and the detailed Sequences of Operation documentation submittal.

B. Do not start functional testing until all controlled components have themselves been successfully functionally tested in accordance with the contract documents.

C. Using a skilled technician who is familiar with this building, execute the functional testing of the control system as required by the CA.

D. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.

E. Demonstrate the following to the Owner's Representative during testing of controlled equipment; coordinate with commissioning of equipment.
   1. Setpoint changing features and functions.
   2. Sensor calibrations.

F. Demonstrate to the CA:
   1. That all functions and features are set up, debugged and fully operable.
   2. That scheduling features are fully functional and set up, including holidays.
   3. Power failure and battery backup and power-up restart functions.
   4. Security and access codes.
   5. Occupant over-rides
   6. Operation and maintenance schedules and alarms.
   7. Other integrated tests specified in the contract documents

G. Perform and submit trend logging on the following using the control system, for minimum period of five (5) days including one weekend, if the control points are monitored by the control system:
   1. Sequential staging ON of equipment; optionally demonstrate manually.
   2. Optimum start-stop functions.
   3. Equipment optimum start/stop functions.

H. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

3.05 OPERATION AND MAINTENANCE MANUALS

A. Add commissioning records to manuals.

3.06 DEMONSTRATION AND TRAINING

A. See Section 23 00 10 for additional requirements.

B. Demonstrate operation and maintenance of HVAC system to Owner's personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.

C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Owner's Representative during Functional Testing.

D. Provide hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned.

E. HVAC Control System Training:
   1. Basic Control System: Provide actual training on the controls themselves for in unit heat pumps, central fans, heat recovery coils, Fire smoke dampers, etc. Upon completion of training, each attendee, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
   2. Provide answers/training for questions by the owner during the warranty period.

F. Provide the services of manufacturer's representatives to assist instructors where necessary.

G. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING AND SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping

B. Insulation

C. Jackets

1.02 RELATED REQUIREMENTS

A. Section 23 00 20 - Basic Materials and Methods; Inserts

1.03 REFERENCE STANDARDS

A. ASHRAE Standard 15 - Safety Standard for Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; (ANSI/ASHRAE Standard 15).

B. ASHRAE Standard 34 - Designation and Safety Classification of Refrigerants; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

C. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

D. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

E. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

F. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

G. Reference standards shall be the latest revision as accepted by the local Authority Having Jurisdiction.

1.04 SYSTEM DESCRIPTION

A. Refrigeration system is a packaged unit.

B. Condensate piping shall be provided.

1.05 SUBMITTALS

A. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.

B. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

C. Test Reports: Indicate results of leak test, acid test.

D. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.

E. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.

1.06 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of documented experience.

1.07 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 for installation of piping system.

B. Welding Materials and Procedures shall conform to ASME (BPV IX) and applicable state labor regulations.

C. Provide Welder Certification in accordance with ASME (BPV IX).

D. Products Requiring Electrical Connection shall be listed and classified by UL as suitable for the purpose indicated.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

PART 2 PRODUCTS

2.01 PIPING

A. Condensate
   1. PVC Schedule 40 solid wall DMV
      a. Pipe shall be manufactured from virgin rigid PVC (polyvinyl chloride) vinyl compounds with a cell class of 12454 as identified in ASTM D 1784. PVC Schedule 40 pipe shall be Iron Pipe Size (IPS) conforming to ASTM D 1785 and ASTM D 2665. Injection molded PVC DWV fittings shall conform to ASTM D 2665.
      b. Fabricated PVC DWV fittings shall conform to ASTM F 1866.
      c. All pipe and fittings are to be produced by a single manufacturer and to be installed in accordance with manufacturer’s recommendations and local code requirements.
      d. The system shall be protected from chemical agents, fire-stopping materials, thread sealant, plasticized-vinyl products or other aggressive chemical agents not compatible with PVC compounds.
      e. The system shall be hydrostatically tested after installation.
      f. Pipe and fittings shall conform to NSF International Standard 14.
      g. Insulation: Condensate piping shall be insulated end to end with closed-cell pipe insulation with a minimum of 1” thick insulation.

B. Pipe Supports and Anchors:
   1. Conform to ASME B31.5.
   2. Hangers for Pipe Sizes 1/2" to 1-1/2": Malleable iron adjustable swivel, split ring.
   3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   4. Vertical Support: Steel riser clamp.
   5. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   6. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded. Zinc plated.

2.02 REFRIGERANT

A. Refrigerant: R32

2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534 Grade 3; use molded tubular material wherever possible. ASTM E84 25/50 for use in plenums.
   1. Minimum Service Temperature: -40 degrees F.
   2. Maximum Service Temperature: 220 degrees F.
   3. Connection: Waterproof vapor barrier adhesive.

B. Usage: Refrigeration/Condensate Piping - Interior / Exterior.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

D. Interior pipe installations: Apply two coats of manufacturer's recommended finish, where insulation is exposed indoors.

E. Inserts: Provide inserts at all support locations; see Section 23 00 20.

F. Exterior pipe installations:

1. Apply one coat of manufacturer's recommended finish
2. Apply Jacket
3. Paint Jacket to match building exterior

2.04 JACKETS

A. Lineset Covers
   1. Manufacturers
      a. Fortress
      b. SpeediChannel
      c. SlimDuct
      d. Approved equal
   2. Sized to cover refrigerant piping and insulation.
   3. UV-, fire-, and weather-resistant black - colored extruded PVC covers; SlimDuct SD-Series or approved equal.
   4. Paint lineset covers to match exterior
   5. Usage: Exterior Piping

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.

B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

C. Slope condensate piping to drain. Where air gaps are utilized cut condensate piping termination at 45 degree angle.

D. Install piping to conserve building space and avoid interference with use of space.

E. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.5.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2" space between finished covering and adjacent work.
   4. Place hangers within 12" of each horizontal elbow.
   5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

H. Provide clearance for installation of insulation and access to valves and fittings.

I. Follow ASHRAE Standard 15 procedures for charging and purging of systems and for disposal of refrigerant.

3.03 FIELD QUALITY CONTROL

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

B. Pressure test system with dry nitrogen according to manufacturer's installation instructions and warranty requirements. Test to no leakage.

END OF SECTION

SECTION 23 31 00
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Duct Materials

B. Ductwork Fabrication

C. Manufactured Metal Ductwork and Fittings

D. Duct Cleaning

1.02 RELATED REQUIREMENTS

A. Section 23 00 20 - Basic Materials And Methods for HVAC

B. Section 23 33 00 - Air Duct Accessories.

C. Section 23 37 00 - Air Outlets and Inlets.

D. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

1.03 REFERENCE STANDARDS

A. ASTM A 36 - Standard Specification for Carbon Structural Steel.

B. ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association.

D. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems; National Fire Protection Association.

E. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association.

F. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association.

G. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.

H. All codes and reference standards shall be the latest revision as accepted by the local Authority Having Jurisdiction.

1.04 PERFORMANCE REQUIREMENTS

A. No variation of duct configuration or sizes permitted except by written permission of the Architect and Engineer. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. Meet or exceed SMACNA requirements for all sheet metal systems.

B. Leakage Testing General Requirements: Maximum permissible leakage shall be as noted in the Washington State Energy Code, or as noted in these specifications, whichever is more stringent.

1.05 SUBMITTALS

A. Product Data: Provide data for all materials.

B. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.

C. Manufacturer's Installation Instructions.

D. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.06 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

1.07 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A, 90B, 96 and SMACNA standards.

1.08 FIELD CONDITIONS

A. Do not install lined duct in wet locations. Contractor to keep ends of lined duct covered at all times. If lined duct becomes wet or dirty, remove from jobsite and replace with new duct. The General Contractor to provide weather protection if his schedule requires the sheet metal subcontractor to working ahead of the building being dried in.

B. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

C. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.01 DUCT ASSEMBLIES

A. Provide duct assemblies as shown on Plans.

2.02 MATERIALS

A. Galvanized Steel Ducts: Hot-dipped galvanized steel sheet, ASTM A 653 FS Type B, with G60/Z180 coating.

B. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
   1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
   2. VOC Content: Not more than 250 g/L, excluding water.
   3. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E84.

C. Insulated Flexible Ducts:
   1. Manufacturers:
      a. Thermaflex Model G-KM
      b. Approved equal
   2. Chlorinated polyethylene core supported by helically wound coated spring steel wire; fiberglass insulation; black polyethylene vapor barrier film.
      a. Pressure Rating: 6" wg positive and 1" wg negative.
      b. Maximum Velocity: 5000 fpm
      c. Temperature Range: -20 degrees F to 200 degrees F continuous.
      d. R-4.2, meeting UL 181, & NFPA 90A - 90B fire codes, self-extinguishing.
      e. GREENGUARD certified for Children and Schools.
      f. Acoustically rated.
      g. Warranted for 10 years
      h. Maximum length 6'.
      i. Install per manufacturer's recommendations.
      j. Run insulated flexible duct as straight as possible.

D. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.

E. Supply/Exhaust ductwork: +/-2” w.g. pressure class, galvanized steel.

F. Hanger Rod: ASTM A 36; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.03 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards and SMACNA High Velocity Duct Construction Standards - Metal and Flexible. Provide duct material, gages, reinforcing, and sealing for operating pressures 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. T's, bends, and elbows: Construct according to SMACNA (DCS).

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 HVAC Duct Construction Standards - Metal and Flexible.

G. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

H. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide minimum 12" long plenum same size as the louver, sloped to drain to the exterior. Line plenum with self-adhering rubberized asphalt flashing as shown on Plans; seal plenum to louver frame and duct. Connect duct to plenum with 45 degree divergence fittings.

I. Contractor may use the Ductmate connection system at his option. System consists of flanges with integral sealants, corner pieces, clips, bolts, cleats and gaskets.

2.04 MANUFACTURED METAL DUCTWORK AND FITTINGS

A. Manufacturers
1. Metal-Fab, Inc.
2. SEMCO Incorporated
3. United McGill Corporation
4. Local shop fabrication by installing contractor.
5. Approved equal

B. Manufacture in accordance with SMACNA HVAC Duct Construction Standards as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated on drawings.

C. Single Wall Round Duct And Fittings: Materials shall be per SMACNA HVAC Duct Construction Standards, Metal and Flexible, Galvanized Sheet Metal. Provide spiral duct.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. General:
1. Install in accordance with manufacturer's instructions.
2. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
3. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
4. Install and seal metal and flexible ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
5. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
6. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

7. Use crimp joints with or without bead for joining round duct sizes 8" and smaller with crimp in direction of air flow.
8. Use double nuts and lock washers on threaded rod supports. Cut rods flush with second nut.
9. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.
10. Connect diffusers to low pressure ducts directly or with 6' maximum length of flexible duct held in place with strap or clamp.
11. Install ductwork and equipment to maintain maximum clearance above floor.

3.02 CLEANING

A. Clean duct systems with high power vacuum machines. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes. Repair any damage caused to duct lining caused by cleaning operation.
   1. Duct cleaning required, when contractor fails to protect duct prior to installation and or keep ends covered once duct is installed.
   2. On remodeled systems, clean all existing ducts prior to connecting new ducts to existing systems. This includes the supply/exhaust air ductwork located in the attic and the vertical chases, and out to the living units.

B. Remove all labels from exposed ductwork, including ductwork in mechanical spaces. Labels may remain on ducts in concealed locations only.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Duct Access Doors
B. Duct Test Holes
C. Fire and Smoke Dampers
D. Flexible Duct Connections
E. Motorized Dampers
F. Remote Access For Volume Control Dampers
G. Sleeves For Ducts Through Non-Fire-Rated Walls
H. Volume Control Dampers

1.02 RELATED REQUIREMENTS

A. Section 23 31 00 - HVAC Ducts and Casings

1.03 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association.
B. NFPA 92A - Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences.
C. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association.
D. UL 33 - Heat Responsive Links for Fire-Protection Service; Underwriters Laboratories Inc.
E. UL 555 - Standard for Fire Dampers; Underwriters Laboratories Inc.
F. UL 555S - Standard for Leakage Rated Dampers for Use in Smoke Control Systems; Underwriters Laboratories Inc.
G. Reference standards shall be the latest revision as accepted by the local Authority Having Jurisdiction.

1.04 SUBMITTALS

A. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.
C. Manufacturer's Installation Instructions: Provide instructions for fire dampers.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 EXTRA MATERIALS

A. Provide six (6) of each size and type of fusible link used on this project.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS

A. Manufacturers:
   1. Krueger

2. Price Industries
3. Ruskin Company
4. Titus
5. Approved equal

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

C. Multi-blade device with radius blades attached to pivoting frame and bracket, steel construction, with push-pull operator strap.

2.02 DUCT ACCESS DOORS

A. Manufacturers:
1. Acudor Products Inc.
2. Greenheck Fan Corporation
3. Nailor Industries Inc.
4. Ruskin Company
5. Approved equal

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1" thick insulation with sheet metal cover.
1. Less Than 12" Square: Secure with sash locks.
2. Up to 18" Square: Provide two hinges and two sash locks.
3. Up to 24" x 48": Three hinges and two compression latches with outside and inside handles.
4. Larger Sizes: Provide an additional hinge.

2.03 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.

2.04 FIRE AND SMOKE DAMPERS

A. Manufacturers:
1. Greenheck Fan Corporation
2. Louvers & Dampers, Inc.
3. Nailor Industries Inc.
4. Ruskin Company
5. Approved equal

B. Combination Fire and Smoke Dampers (CFSD)
1. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
2. Provide factory sleeve and collar for each damper. Minimum sleeve length 17".
3. Multiple Blade Dampers: Fabricate with 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2" actuator shaft. Similar to Greenheck FSD.
4. Operators: UL listed and labeled spring return electric type suitable for 120 volts, single phase, 60 Hz. Locate damper operator on interior of duct and link to damper operating shaft. Belimo or approved equal.
5. Electronic Fuse Link (EFL): EFL shall activate at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.
6. Access panels for combination fire smoke dampers shall have a phenolic label on the exterior access panel stating "Combination Fire Smoke Damper" in a minimum of 3/8" high letters. The label shall also list a specific identifier for each CFSD, either in conjunction with a fire life safety monitoring and testing system, or as a stand-alone system. Minimum size of access panel is 12" x 12".

7. Grille-Access Out-of-Wall CFSD: Actuator is accessible by removing grille; similar to Greenheck GFSD. Utilize for hallway CFSD's
8. Accessories and Options:
    a. Open/Closed indicator
    b. Smoke detector
    c. Resettable Link

C. FLEXIBLE DUCT CONNECTIONS
1. Wherever ducts make connection with any air-handling device such as supply fans, exhaust fans, etc., flexible connections shall be provided.
2. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
3. Flexible Duct Connections: Fabric crimped into metal edging strip.
    a. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 ounces per square yard.
    b. Net Fabric Width: Approximately 2" wide.

2.05 MOTORIZED DAMPERS

A. Dampers shall be full size of duct, be sealed between damper frame and duct, and shall operate without binding on duct wall. Provide access panels for motorized dampers, 12" x 12" minimum.

B. Manufacturers
1. Ruskin
2. Greenheck
3. Vent Products
4. Air Balance
5. Johnson Control
6. Honeywell
7. Approved equal.

C. General:
1. Performance: Test in accordance with AMCA 500-D.
2. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gage.
3. Blades: Galvanized steel, maximum blade size 6" wide, 48" long, minimum 22 gauge, attached to minimum 1/2" shafts with set screws.
4. Blade Seals: Synthetic elastomeric mechanically attached, field replaceable. Suitable for 0 degrees F to 180 degrees F operating temperature.
5. Jamb Seals: Spring stainless steel.
6. Shaft Bearings: Oil impregnated sintered bronze.
7. Linkage Bearings: Oil impregnated sintered bronze.
8. Blade linkages shall be attached at mid-point of blade length.
9. Leakage: Less than 1% based on approach velocity of 2000 ft/min and 4" wg.
10. Maximum Pressure Differential: 6" wg.
11. Temperature Limits: -40 to 200 degrees F.
12. Provide actuators as required for application.
13. Provide one actuator for every 20 sq. ft. of damper.
14. Actuators shall utilize spring return on all outside air applications.
15. Actuators shall be manufactured by Belimo or approved equal.

D. Low Leakage Two-Position type

1. Parallel blade type with construction and performance same as specified for low leakage modulating type.
2. Airfoil blades shall be equipped with 0.50" minimum thickness axles, stainless steel or bronze sleeve bearings, field-replaceable EDPM or vinyl edge seals, and a flexible aluminum or stainless steel compression type jamb seal.
3. Leakage shall not be greater than 4 cfm/square foot at 1.0” static pressure difference.
4. Damper shall have a maximum operating static pressure differential of 6.00" and be capable of operating with face velocities up to 3,000 fpm.
5. Unless otherwise indicated, dampers shall be same size as duct; where dampers are not installed in a duct, dampers shall be sized for a maximum pressure drop of 0.05" at maximum design airflow.
6. Actuators shall be manufactured by Belimo or approved equal.
7. Ruskin CD50 or approved equal.

2.06 AUTOMATIC CONTROL DAMPER - ACTUATORS

A. General: Provide smooth proportional control with sufficient power for air velocities 20% greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two-position control and for fail safe operation.
   1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
   2. Provide one operator for maximum 20 square foot damper section.

B. Electric Operators:
   1. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.
   2. Electric control actuation shall utilize direct coupled actuators. Belimo or approved equal.
   3. Damper actuators shall be Brushless DC Motor Technology with stall protection, bidirectional, fail-safe spring return (where shown on Plans or in sequence of operation as normally open or normally closed), all metal housing, manual override, and independent adjustable dual auxiliary switch.
   4. The actuator assembly shall include the necessary hardware and proper mounting and connection to a standard 1/2" diameter shaft or damper blade.
   5. Actuators shall be designed for mounting directly to the damper shaft without the need for connecting linkages.
   6. Actuators having more than 100 lb-in torque output shall have a self-centering damper shaft clamp that guarantees concentric alignment of the actuator output coupling with the damper shaft. The self-centering clamp shall have a pair of opposed "v" shaped toothed cradles; each having two rows of teeth to maximize holding strength. A single clamping bolt shall simultaneously drive both cradles into contact with damper shaft.
   7. All actuators having more than a 100 lb-in torque output shall accept a 1" diameter shaft directly, without the need for auxiliary adapters.
   8. All actuators shall be designed and manufactured using ISO900 registered procedures, and shall be listed under Standards UL873 and CSA22.2 No. 24-93 I.
   9. Dampers shall be interlocked with fans

2.07 REMOTE ACCESS FOR VOLUME CONTROL DAMPERS

A. Manufacturers:
   1. Ventlock
   2. Young Regulator
   3. United Enertech
   4. Approved equal

B. Provide Ventlock Model 666 concealed damper regulator, where dampers are located above a hard lid ceiling or are otherwise inaccessible.

2.08 SLEEVES FOR DUCTS THROUGH NON-FIRE-RATED WALL

A. Provide sheet metal sleeves around ducts, penetrating through walls or floors. Pack opening around duct with fiberglass and caulk with resilient acoustical caulk and then install 3" x 3" - 18 gage sheet metal closure angle all around duct, overlapping corners, secure to duct and wall. Caulk and install closure angle on both sides of wall. When insulated on the exterior, butt to closure angles.

2.09 VOLUME CONTROL DAMPERS

A. Manufacturers:
   1. Louvers & Dampers, Inc.
   2. Nailor Industries Inc.
   3. Ruskin Company
   4. Greenheck Fan Corporation
   5. Approved equal

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Volume Control Dampers, shall be installed on all branch duct take-offs to diffusers, grilles and registers. Do not provide or use dampers at the face of the diffuser, grilles or registers for balancing.

D. Splitter Dampers:
   1. Material: Same gage as duct to 24" size in either direction, and two gages heavier for sizes over 24".
   2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
   3. Operator: Minimum 1/4" diameter rod in self aligning, universal joint action, flanged bushing with set screw .

E. Single Blade Dampers: Fabricated for duct sizes up to 6" x 30"

F. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8" x 72". Assemble center and edge crimped blades in galvanized channel frame with suitable hardware.

G. End Bearings: Except in round ducts 12" and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

H. Quadrants:
   1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
   2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
   3. Where rod lengths exceed 30", provide regulator at both ends.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 for duct construction and pressure class.

B. Provide additional backdraft dampers on exhaust fans or exhaust ducts nearest to the outside and where indicated.

C. 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" x 8" size for hand access, 18" x 18" size for shoulder access, and as indicated. Provide 4" x4" for balancing dampers only. Review locations prior to fabrication.

D. Provide duct test holes where indicated and required for testing and balancing purposes.

E. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

F. Install combination smoke and fire dampers in accordance with NFPA 92A.

G. Demonstrate re-setting of fire dampers to Owner's representative.

H. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent the equipment.

I. 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.

J. Provide balancing/volume dampers on all branch duct take-offs to diffusers, grilles, and registers.

3.03 COMMISSIONING

A. A factory-authorized commissioning agent shall fully demonstrate all functions and confirm operation of the CFSD dampers and interlock of the fire life safety system.

END OF SECTION

SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall Supply Registers/Grilles.

B. Wall Exhaust/Return/Transfer Registers/Grilles.

1.02 REFERENCE STANDARDS

A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.

B. ARI 890 - Standard for Air Diffusers and Air Diffuser Assemblies; Air-Conditioning and Refrigeration Institute.

C. ASHRAE Standard 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets; American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.

D. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association.

E. Reference standards shall be the latest revision as accepted by the local Authority Having Jurisdiction.

1.03 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, throw, drop, terminal velocity and noise level.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

B. Test and rate air outlet and inlet performance in accordance with ASHRAE Standard 70.

C. Test and rate louver performance in accordance with AMCA 500-L.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Grilles/Registers/Diffusers
   1. Titus
   2. Price Industries
   3. MetalAire by Greenheck
   4. Kees
   5. Krueger
   6. Carnes Company
   7. Tuttle & Bailey
   8. Approved equal

2.02 WALL SUPPLY REGISTERS/GRILLES (SG)

A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille.

B. Frame: 1-1/4" margin with countersunk screw mounting and gasket.

C. Fabrication: Aluminum extrusions with factory off-white enamel finish.

2.03 WALL EXHAUST/RETURN/TRANSFER REGISTERS/GRILLES (RG, WTG)

A. Type: Steel grille with 3/8” bar spacing and 15°deflection.

B. Frame: 1-1/4" margin with countersunk screw mounting.

C. Fabrication: 16 gauge steel frames and 14 gauge steel blades, with factory off-white enamel finish. Bars shall be reinforced by perpendicular, steel support bars spaced on 6” maximum centers.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Air Terminals
   1. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
   2. Terminals installed in suspended ceiling systems shall be attached or supported as required by the latest appropriate Building Code for "Suspended Acoustical Ceilings.”
   3. Install diffusers to ductwork with air tight connections.
   4. Install grilles and registers to ductwork with air tight connections. Use screws and foil tape only; do not use duct tape.
   5. Provide balancing/volume dampers on all branch duct take-offs to diffusers, grilles and registers.
   6. Paint ductwork visible behind air outlets and inlets matte black.
   7. Where grilles, registers, and diffusers are installed on exposed ductwork, care shall be completed to maintain head clearance. Utilize short diffuser cans where needed.

C. Duct Openings: Where no grille, register, or diffuser is called out at duct openings, provide 1/2” hardware cloth over openings.

END OF SECTION

SECTION 23 81 19

SELF-CONTAINED AIR-CONDITIONERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Packaged terminal heat pump units.

B. Cabinet.

C. Wall sleeves.

D. Louvers.

E. Chassis.

F. Controls.

1.02 RELATED REQUIREMENTS

A. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AHRI 210/240 - Standard for Performance Rating of Unitary Air Conditioning and Air-Source Heat Pump Equipment; Air-Conditioning, Heating, and Refrigeration Institute.

B. AHRI 270 - Sound Rating of Outdoor Unitary Equipment; Air-Conditioning, Heating, and Refrigeration Institute.

C. Reference standards shall be the latest revision as accepted by the local Authority Having Jurisdiction.

1.04 PERFORMANCE REQUIREMENTS

A. Air Cooled Units: See schedule on Plans.

1.05 SUBMITTALS

A. Product Data: Provide drawings indicating dimensions, rough-in connections, and electrical characteristics and connection requirements.

B. Manufacturer's Instructions: Include assembly instructions, support details, connection requirements, and start-up instructions.

C. Operation and Maintenance Data: Provide maintenance data, parts lists, controls, and accessories. Include trouble-shooting guide.

1.06 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

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

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

1.07 MOCK-UP

A. Install one unit that includes inside enclosure cabinet, wall sleeve, and wall louver.

B. Locate where directed.

C. Mock-up may remain as part of the Work.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect finished cabinets from physical damage by leaving factory packing cases in place before installation and providing temporary covers after installation.

1.09 WARRANTY

A. Provide a five year manufacturer's warranty on units, covering parts and labor.

B. Compressor Warranty – 10 Years from Delivery:

C. The compressor is warranted against defects in materials or workmanship for ten (10) years from the date of delivery. A replacement compressor will be supplied at no cost during this period under the terms of this warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Ephoca

B. Approved equal

2.02 HEAT PUMP UNITS

A. Description: Unitary self-contained heat pump unit with cabinet and controls; fully charged with refrigerant. The unit shall be a concealed ducted indoor unit that mounts within a mechanical closet with a return and a front and vertical discharge supply. Contained within the unit shall be a twin rotary, inverter-driven compressor, refrigerant system, all factory wiring, piping, electronic modulating Electronic Expansion Valve (EEV), heated condensate pan, control circuit board, an outdoor fan with EC motor, and two indoor fans with independent EC motors. The unit shall be capable of providing static pressure up to 0.60 inWC for indoor ducting and up to 0.70 inWC for outdoor ducting. The unit shall be less than 12" deep and shall require an installation space of less than 12" deep. The unit shall have an Auto-restart function that allows the unit to resume operation after a power interruption.

B. Electrical Characteristics: See schedule on Plans.

C. Energy Efficiency: Energy Efficiency Rating (EER)/Coefficient of Performance (COP) not less than requirements of Washington State Energy Code, or local jurisdiction energy code, whichever is the most stringent.

D. Refrigerant shall be R32

E. Condenser fan:
1. The fan motor shall be a variable-speed EC.
2. The fans shall be capable of providing a static pressure up to 0.70 inWC for external ducting.
3. The fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
4. The fan motor shall be electrically protected.
5. The fan shall be protected with a metal grille.
6. The fan blowing shall provide horizontal discharge.

F. Indoor fans:
1. There shall be two independent fans.
2. Each fan shall have its own variable-speed EC motor.
3. The fans shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
4. The fans shall be capable of providing a static pressure up to 0.60 inWG. for internal ducting.
5. The fans shall offer three (3) speeds: Low, Mid, and High.
6. The fans shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between the controller set-point and space temperature.
7. The unit shall offer the possibility of preventing the fan from operating when the temperature is satisfied in heating mode.

G. Condenser Coil:
1. The condenser coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
2. The coil fins shall have a factory-applied corrosion-resistant finish.
3. The coils shall be pressure tested at the factory. H. Indoor Coil:

4. The indoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
5. The coils shall be pressure tested at the factory.

H. Filter:
1. Return air shall be filtered using a MERV3 washable air filter.
2. The filter shall be on the sides of the unit.
3. The filter construction shall include a Fungicide agent.

I. Drainage:
1. The unit shall be equipped with an integral insulated drain pan.
2. The drain pan shall have a heating element.
3. Provide a connection to the piped condensate drain system to a code-approved location.

J. Condensate Evaporator System:
1. A condensate drain is not required for cooling, as condensate is evaporated.
2. The unit shall contain a condensate evaporator system comprised of a pump and misting nozzles.
3. The pump shall pump the condensate above the height of the condenser coil, where the mister nozzles shall drizzle the condensate onto the coil, where it is evaporated.

K. Electric-Resistance Heating Coil:
1. The electric-resistance heating element shall work in tandem with the heat pump when the heat pump's output is insufficient to heat the room.
2. The unit shall be available with a 1,800-watt supplemental electric-resistance heating element with a contactor and high-temperature-limit switch.

L. Control and Communication
1. The unit shall be controlled by integral microprocessors.
2. The unit includes an integrated onboard controller.
3. The unit includes an integrated WiFi controller.
4. Provide with GWX gateway control board to enable any third-party thermostat to control the unit.
5. Provide with King Electric heat kit, King Model# KRF-B-KIT. Kit to include KRFLR 120v/240v electric heat controller, KRFR heat pump relay kit, and KRFTP-B wireless programmable thermostat.

M. Cabinet:
1. The cabinet shall be fabricated of 18-gauge galvanized steel.
2. The cabinet shall be finished in RAL 9003.
3. The cabinet shall be capable of connecting to a return air duct or grille from the sides of the unit.
4. The cabinet shall be capable of connecting to a supply air duct or grille at the front or top of the unit.
5. The cabinet shall have removable access panels.

2.03 ENCLOSURE CABINET

A. Cabinet shall be custom manufactured by Thermaduct and shall be full height floor to ceiling and shall feature integral grilles and hinged doors. Cabinet sizing to match plans and be field verified for fitment in apartment units.

B. Cabinet shall be minimum 16-gauge powder coated steel construction with insulated panels.

2.04 WALL SLEEVES AND LOUVERS

A. Wall Sleeves: Steel with protective coating.

B. Louvers: Provide factory combination intake/exhaust louvers color and finish selected by owner. Paint to match building exterior. Owner to select color.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Coordinate installation of units with architectural, mechanical, and electrical work.

C. Provide all accessories as needed for complete installation.

D. Touch-up, repair, or replace damaged products before completion.

3.02 SYSTEM STARTUP

A. Provide the services of manufacturer's field representative for starting and testing unit.

B. Prepare a manufacturer’s startup report and turn over to the Owner’s Representative.

3.03 COMMISSIONING

A. All commissioning activities shall be completed by the manufacturer’s factory-authorized personnel. The manufacturer’s factory authorized personnel agent shall be an employee of the system manufacturer or an employee of the manufacturer’s representative.

B. Completion of the commissioning process shall verify that the system has been installed per the Engineer’s design intent and complies with the manufacturer’s engineering and installation specifications related to the used equipment.

C. Compliance with federal, state, and local codes, as well as other authorities having jurisdiction, is not part of this process and is the

D. responsibility of the installing contractor.

E. The unit is 100% level on the vertical and horizontal axes.

F. The unit is securely fastened to supporting materials.

G. The unit cabinet has no visible damage.

H. Condenser coils and fans have no visible damage.

I. Interior vents, supply, and return are not blocked by any furniture, plants, or window coverings.

J. External vent holes are 100% aligned internally with the unit's vent holes.

K. Exterior vents are not blocked by walls or plantings.

L. Exterior grilles are installed correctly.

M. Exterior grilles are properly sealed.

N. Controls are connected and operable, cycle unit through fan speeds and heat/cool operation.

O. Return air and outdoor vent air filters are installed and clean.

P. The condensate drain is functioning properly.

END OF SECTION

SECTION 26 05 00
COMMON WORK FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY OF WORK

A. The extent and location of Electrical Work is shown in the Contract Documents. This Section includes general requirements for accomplishing electrical Work as specified herein and indicated on the Drawings.

B. Related Documents: The provisions and intent of the Contract, the General and Supplementary Conditions, and Division 1 Specification Sections, apply to the Work as if specified in this Section.

C. Conform to General Conditions, Supplementary Conditions, Division 01, Division 26, Division 27, and Division 28.

D. Review the Specifications and Drawings for coordination with additional requirements and information that apply to work under this Specification.

1.02 GOVERNING CODES, STANDARDS AND REFERENCES

A. NFPA 70: National Electrical Code (NEC)

B. NFPA 70 E: Standard for Electrical Safety in the Workplace

C. State of Washington Dept. of Labor & Industries.

D. Underwriters Laboratories, Inc.

E. WAC 296-45

F. State of Washington safety rules and health standards

G. Americans with Disabilities Act (ADA)

H. Local codes and ordinances

1.03 GENERAL REQUIREMENTS

A. Review the Specifications and Drawings for coordination with additional requirements and information that apply to work under this Section.

B. Provisions within the Specifications and Drawings describe minimum guidelines for electrical installations.

C. Where industry standard design practices are published for use by design professionals, such guidelines shall be used as a minimum basis of design; e.g., IESNA Recommended Practices, BICSI Communication Distribution Standards, ANSI/TIA/EIA Standards and IEEE Publications.

D. Electrical efficiency, life-cycle cost and maintainability of proposed systems shall be considered prior to product selection.

E. Availability (lead times) and potential obsolescence shall be considered during product selection. Potential long-lead items shall be reviewed with the Owner’s Representative.

F. Specified items that are essential to a facility’s functional use shall have locally available spare parts and service and not be at risk to be discontinued by the manufacturer for a minimum of 5 years.

G. All low-voltage cables shall be labeled with computer printed, sleeve type, wire markers. The designation on the wire markers shall match those on the shop drawings.

H. The Owner shall be instructed on the operation of all systems at substantial completion and again three months after the initial instruction period.

1.04 SUMMARY

A. Provide supervision, labor, materials, tools, equipment/machinery, temporary power and lighting, and other services necessary to complete the work for complete operations described herein and as shown on the Drawings.

B. The provisions and intent of the General Conditions, Special Conditions, and General Requirements apply to the work as if specified in this Section and other Sections of the Specifications. Provide the electrical work as indicated or specified in other Sections of the Specifications and Drawings of the Contract Documents.

C. Execute electrical work in strict accordance with the latest edition of the National Electrical Code and governing local ordinances, codes, and regulations. Assure the strict conformity of electrical equipment, materials, construction methods, tests, and definitions with the established standards of the following in their latest adopted revision: Underwriter's Laboratories, Inc. (UL), and National Electrical Manufacturers Association (NEMA).

D. Furnish and install all equipment in the Contract in harmony with other trades to provide completed systems with neat, finished appearance, using approved methods of the trade. Only good workmanship will be accepted. If, in the judgment of the Owner's Representative, any portion of work not installed in a workmanlike manner or left in a rough, unfinished condition, remove the equipment, reinstall same, patch and paint surrounding surfaces satisfactory to the Owner's Representative, with no increase in cost.

E. Mounting details of equipment, devices, light fixtures, raceways, junction boxes and the like are not usually shown or specified. Provide per industry standard practice and code requirements as necessary for proper installation and operation the same as if herein specified or shown.

F. Provide installation means and methods of all equipment, devices, light fixtures, raceways, junction boxes and the like per industry standard practice and code requirements as necessary for proper configuration and operation as if herein specified or shown.

G. All installations shall comply with ADA requirements.

H. Purchase permits, licenses, and approvals required for execution of the Work.

I. Test the entire electrical installation to assure compliance with Codes and proper system operation.

J. Electrical systems commissioning consists of static checks of component and system installations and actual testing of equipment conditions and functions.

K. The Commissioning Authority shall review and approve, prior to use, all test procedures and forms used and shall witness a varying fraction of the checks and testing performed by the Contractor. The Commissioning Authority shall review the completed check and test documentation of the Contactor for all checks and tests.

1.05 CALCULATIONS AND LABELLING

A. Provide complete Arc-Flash Hazards Calculation Report and label all equipment required per NFPA 70E to properly identify arc-flash hazards. Contractor is required to pay for and submit Arc-Flash Hazards Calculation to Owner's Representative and Engineer for review and approval prior to commencing work.

B. Provide complete Overcurrent Protective Device Coordination Study Report and install all devices per settings contained in the Coordination Study Report. Contractor is required to pay for and submit Coordination Study Report to Owner's Representative and Engineer for review and approval prior to commencing work. All information required for the report shall be provided and gathered by contractor.

C. For all NEC 700 systems, a selective coordination study shall be performed. Contractor is required to pay for and submit Coordination Study Report to Owner's Representative and Engineer for review and approval prior to commencing work. All information required for the report shall be provided and gathered by contractor.

1.06 DEFINITIONS

A. The terms “or other reviewed and approved Manufacturers”, “or approved equal” and “or equal” means final approval by the Architect or Engineer of a material or piece of equipment substituted for that which is shown in the Contract Documents.

B. The word “provide” as used in these Specifications or on the Drawings shall mean “furnish, install, and complete connection per factory instructions”.

C. The term Mechanical Contractor (M.C.) and Electrical Contractor (E.C.) as used in these Specifications or on the Contract Drawings, refer to those subcontractors working under the direction of the General Contractor (G.C.).

D. The term “Engineer” shall refer to the licensed professional electrical engineer who is responsible for the preparation of the electrical documents.

1.07 EQUIPMENT

A. All materials shall be UL listed and labeled.

B. The interior of all electrical equipment shall be thoroughly cleaned prior to final acceptance.

C. All equipment and receptacles shall have permanent panel name and circuit number on equipment, disconnects, coverplates, etc.

1.08 SUBMITTALS

A. Approval Submittals:
1. Statement of Manufacturer’s Qualifications.
2. Statement of Installer’s Qualifications.
3. Product Data: Submit and clearly identify product data, selection, and options.
4. Shop Drawings: Submit all required shop drawings. Where product data and shop drawings are required for the work, submit both at the same time.

B. Shop Drawings:
1. Shop drawings produced in AutoCAD shall be provided for each low-voltage system (data, fire alarm, security, etc.) and specialty systems (lighting controls, etc.). Shop drawings shall show all device-to-device wiring. All as-builts shall be delivered in electronic format.
2. Shop drawings shall be based on the final room numbers established by the Owner or Architect; not the room numbers shown on the Architectural Floor Plans.
3. Provide as-built shop drawings for all systems. As-builts shall show the locations of all components, conduit runs and cables utilized.
4. Catalog cuts of equipment, devices, and materials requested by the specification sections.
    a. Catalog information includes technical specifications and application information, including ratings, range, weight, accuracy, etc.
    b. Catalog cuts shall be edited to show only the items, model numbers, and information which apply to the submittal requirements. Edit catalog cuts to indicate only those items, models, or series of equipment to be furnished. Cross out or remove all extraneous materials information. Clearly identify all configuration options for the equipment to be furnished.
    c. Catalog cuts shall be assembled in a folder. Each folder shall contain a cover sheet, indexed by item, and cross-referenced to the appropriate specification paragraph.
5. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.
6. Manufacturer Approval Drawings: Equipment that is laid out, configured, or designed by

manufacturer based on performance specifications only shall be submitted to the Engineer for approval prior to release of drawings for manufacturing.

C. Quality Assurance Submittals:
   1. Test and Inspection Results.

D. Closeout Submittals:
   1. Operations and Maintenance Manual Content.
   2. Spare Parts and Materials.

E. Substitutions:
   1. Conform to Division 01.
   2. The naming of a certain brand or make or manufacturer in the Specifications is to establish a quality standard for the article desired. The Contractor is not restricted to the use of the specific name brand or manufacturer unless so specified as “no substitution”. However, substitution request is required and permitted only as specified in Division 01.
   3. The Contractor shall assume full financial responsibility for any and all additional expenses arising from the use of a substitute product.

1.09 QUALITY ASSURANCE

A. General: These Specifications and Drawings are intended to cover a completed installation of systems. The omission of expressed reference to any items of labor or material for the proper execution of the work in accordance with present practice of the trade shall not relieve the Contractor from providing such labor and materials. Refer to the Drawings and Shop Drawings or other trades for additional details, which affect the proper installation of this work.

   1. The electrical drawings are diagrammatic and are not intended to show all raceway, wiring, exact locations of equipment, terminations, or number or types of fittings required by the electrical system. Provide all related electrical Work which is specified herein, diagrammed or scheduled on the electrical drawings, required by code enforcing agencies and as indicated on other details or elevations for complete and operating electrical systems. Since the drawings of floor, wall, and ceiling installation are made at a small scale, outlets, devices, equipment, etc. are indicated only in their approximate location unless dimensioned or otherwise indicated. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned and coordinate such locations with the Work of other trades to prevent interferences. Verify all dimensions on the job. Do not scale the electrical drawings. Refer to Architectural and Mechanical shop drawings and project drawings for dimensions as applicable.

B. Conform to requirements of NFPA 70.

C. Conform to the latest edition of the NECA Standards for good workmanship in the electrical construction manual.

D. Provide all equipment included and as necessary and in harmony with other trades to provide completed systems with neat, finished appearance, using approved methods of the trade. Only good workmanship will be accepted. If, in the judgment of the Owner’s Representative, any portion of the work has not been installed in a workmanlike manner or left in a rough, unfinished condition, remove the equipment, reinstall same, patch and paint surrounding surfaces satisfactory to the Owner’s Representative, with no increase in cost to the Owner.

E. All materials shall be new, unless noted otherwise. Properly store all materials and equipment for protection from physical damage or damage due to corrosion.

F. Review accessibility of equipment for operation, maintenance and repair prior to installation. Proceed with installation only after unsatisfactory conditions have been corrected

G. Equipment Manufacturer Qualifications: Equipment manufacturers shall have at least 10 years experience in manufacturing products and accessories similar to those for this Project, with a record of successful in-service performance.

H. Before submitting bid, Contractor is strongly encouraged to visit the site and examine existing conditions by which to provide a complete and accurate bid.

I. All inspections and special inspections required by all relevant codes and required by AHJ are to be performed.

J. Coordinate with local AHJ prior to commencing work to ensure that all inspections and special inspections will be performed at the correct time during construction.

K. A Certified Testing Company shall perform the work of this Section and shall be qualified to test electrical equipment and is a NETA (National Electrical Testing Association) certified testing agency. The Certified Testing Company shall not be associated with the manufacturer(s) of the equipment or systems under test.

L. The Contractor shall provide all test equipment necessary to fulfill the checks and testing requirements. Test equipment shall have been calibrated within one (1) year of its use on this Project.

M. Installer Qualifications: An authorized representative who is trained and approved by the manufacturer.

1.10 COORDINATION AND SCHEDULING

A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.

   a. Match components and interconnections for optimum performance of specified functions.

B. Coordinate Work of this Section with those in Section specifying distribution components that are monitored or controlled by power monitoring and control equipment.

C. Coordinate and schedule electrical Work with the Work of other trades. Every reasonable effort shall be made to prevent conflicts as to space requirements, dimensions, locations, code required working spaces, access openings, drawout and removal spaces or other matters tending to obstruct or delay the Work of other trades. All changes caused by failure to coordinate shall be made at the Contractor's expense.

D. All work areas are to be kept clean and clear to permit access and egress of personnel and equipment at all times.

1.11 ELECTRONIC 3D COORDINATION

A. Contractor shall provide a 3-dimensional building model or a building information model (BIM) of the following systems:

   1. Conduits 2-inches and larger.
   2. Conduits in support racks or groups of four or more, including structural supports.
   3. Pull boxes.
   4. Electrical Equipment
   5. Disconnect Switches
   6. Luminaires and Lighting Control Devices
   7. Cable Tray
   8. Data/Telecommunication Devices
   9. Security/Intrusion/Access Control Devices
   10. Audio Visual Devices
   11. Fire Alarm Devices and Equipment

B. The 3-dimensional building model shall be compatible with the clash detection software utilized by the General Contractor.

C. Contractor shall utilize the clash detection software to determine field conflicts by comparing the

3-dimensional building models of the other systems. Contractor shall provide offsets and perform rerouting to fit Work in available space. Include provisions for such requirements in bid.

D. Contractor is required to attend and participate in meetings to coordinate work on site utilizing visual representation of a 3-dimensional building model. Meeting participation is required until conflicts are resolved.

E. Once conflicts in the 3-dimensional building model are resolved, contractor shall use the model to develop 2-dimensional shop drawings.

F. Work shall not commence until the 3-dimensional building model has been reviewed with subcontractors in the presence of the Architect and Engineers.

1.12 WARRANTY

A. Warranty workmanship and components of the work excluding incandescent and fluorescent lamps for a period of one-year from the date of final acceptance. Remedy any defects in workmanship and repair or replace any faulty equipment that fails within the warranty period without additional cost to the Owner. Assure cleanliness of lamps and fluorescent tubes and replacement of defective units at the time of final acceptance.

B. Warranty shall be manufacturer's standard or a minimum of one year unless noted otherwise in Division 26 Electrical Sections.

1.13 CLOSEOUT DOCUMENTS

A. Conform to Division 01.

B. These drawings shall be reviewed monthly prior to final approval of pay request. Upon completion of the Project, the Contractor shall submit these drawings for final approvals.

C. Operation and Maintenance Manuals: Conform to Division 01.

D. Warranties:
1. Conform to Division 01.
2. Submit all subcontractor warranties.
3. Submit all manufacturer warranties.

1.14 OPERATION AND MAINTENANCE MANUALS

A. Provide Operation and Maintenance Manuals in accordance with Division 01.
1. Provide one preliminary bound set of Operation and Maintenance Manuals including maintenance information and parts list furnished by the manufacturer with the equipment, together with supplementary drawings where necessary to itemize serving and maintenance points. Include periodic maintenance, methods of operation, seasonal requirements, manufacturer's data and warranty forms. Provide address and 24-hour phone number of firm responsible under warranty. Items requiring service or correction during the warranty period shall be serviced within 24-hours of notification by the Owner. Data in manuals shall be neat, clean copies, and posted on 8-1/2" x 11" sheets, typed, operation and maintenance instructions for each item of equipment installed. Drawings shall be accordion folded. An index shall be provided with all contents listed in an orderly presentation according to Specification Section.
2. Number of Copies: The preliminary set of the O&M Manual shall be presented to the Owner's Representative for review of content. After this set has been reviewed and accepted, two or as indicated in Division 01, additional copies shall be provided.
3. Binding: Binders shall be as specified in accordance with Division 01, or if not specified in Division 01, binders shall be single touch, locking, D-Ring Type. Covers shall be black printed with the name of the job, the Owner, Architect, Engineer, Contractor, and the year of completion. The back edge shall be imprinted with the name of the job, the Owner, and the year of completion. Each copy shall have typewritten index and tabbed dividers between equipment categories. Binder shall have sufficient capacity to contain all data sheets and not exceed 3/4 of fill capacity.

1.15 DELIVERY, STORAGE, AND HANDLING

A. Schedule materials, equipment, and light fixture deliveries and make all arrangements as necessary to complete all work in accordance with the project construction schedules. Provide schedules of work to the Owner's Representative as directed during construction.

B. Schedule deliveries and unloading to prevent traffic congestion, blocking of access, and interference with work. Arrange deliveries to avoid larger accumulations than can be suitably stored at site. Provide for continuity of supply to avoid change of supplier or change in brand of materials during any phase of work.

C. Deliver packaged materials to site in manufacturer's original, unopened, labeled containers. Do not open containers until approximate time for use. Store materials at locations that will not interfere with progress of work. Arrange locations of storage areas in approximately order of intended use.

D. Store materials in a manner that will prevent damage to materials or structure, and that will prevent injury to persons. Store cementitious materials in dry, weathertight, ventilated spaces. Store ferrous materials to prevent contact with ground and to avoid rusting and damage from weather.

E. Provide documentation to the Owner's Representative for any claim of material, equipment and light fixture deliveries not able to meet construction schedules.

1.16 PROJECT CONDITIONS

A. Field verify and examine existing conditions.

B. Verify requirements for temporary electrical power and construction power. Temporary electrical power must be provided to keep existing facilities fully operational during construction. Contractor shall be responsible to ensure compliance with this requirement.

C. Power outages shall be kept to an absolute minimum. Any essential outages required in the course of construction, whether for temporary services, cutovers, or testing, shall be closely coordinated with the Owner and shall occur at times approved by the Owner.

D. Verify requirements for permanent power and telecommunication service requirements.

E. Identify existing conditions and requirements for cutting, patching, excavation, core drilling, etc.

F. Include all costs to provide the electrical installation associated with the existing conditions for the best workmanship and operation according to the intent of the Specifications and Drawings.

G. Report to the Owner's Representative any condition that might prevent the installation of the equipment in the manner intended.

1.17 EXISTING CONDITIONS

A. Any "as-built" or record drawings of existing work presented in these Contract Documents are for information only and may not accurately represent existing conditions. Field-investigate all existing facilities modifications to ascertain the exact physical and electrical conditions in each case. After field investigation, revise as required installation and interface wiring drawings to conform to actual conditions and comply with codes and Contract requirements. Submit revisions to the Owner's Representative. Provide a detailed design and implement the proper method for physical installation and interface wiring for the required modifications.

1.18 DEMOLITION

A. General: De-energize circuits in demolition areas to ensure a safe condition.

B. Existing material that is not to be reused or is not requested by the Owner to be retained shall be removed from the site and shall become the property of the Contractor for salvage. All materials removed from the site shall be disposed of at facilities licensed for the material.

C. In areas of where alterations are to be done, existing conduits may be reused, with the approval of the Engineer, in their origin, unless noted otherwise.

1. Wiring that is discovered with damaged or deteriorating insulation shall be replaced with new.
2. No existing conduit or wiring once removed may be reused, unless noted otherwise.

D. Remove all unused exposed conduit except where located in or above existing construction, which is not being altered and would require removal and replacement of the existing construction.

1.19 ELECTRICAL EQUIPMENT INSTALLATION

A. Comply with Division 1 General Requirements Sections for environmental regulatory requirements, quality control, construction facilities and temporary controls, traffic control, access control, and signage requirements.

B. National Electrical Code Compliance: Comply with applicable portions of National Electrical Code as to the type of products used and provisions for electrical power connections.

C. Underwriters Laboratories acceptance: All material and equipment within the scope of the UL Re-examination service shall be approved by Underwriters Laboratories, Inc. for the purpose for which they are used and shall bear their label.

D. Cutting and Patching: Provide and coordinate the locations of all openings required in the building construction for installation of the Work.

1. Drill penetrations required through existing concrete slabs or walls with a diamond core drill. In no case shall any structural member be cut.
2. Provide approved sleeves as required for electrical penetrations through floors and walls. Seal all openings around conduits in sleeves with a material of equal fire rating as the surface penetrated.
3. Obtain written approval from a Structural Engineer licensed in the State of Washington prior to cutting any reinforcing bars.
4. Provide weekly updated Submittal Log of all penetrations and cuts performed.

E. Equipment Accessibility: Comply with applicable codes and install equipment to be accessible for operation, maintenance or repair. Equipment deemed inaccessible shall be reported to the Engineer, and relocated as directed.

F. Electrical Work Exposed to Weather: Provide weatherproof enclosures and corrosion protection for all ferrous metal portions of electrical Work exposed to weather, including conduit, clamps, supports, and hardware.

1. All galvanized electrical equipment exposed to the weather shall be painted to prevent leaching of zinc into the stormwater system. Paint coating shall be a minimum of 3 mils thick, and application as part of the manufacturing process is preferred over painting in the field.

1.20 EARTHWORK

A. Existing Underground Utilities: Verify, before any excavation, the location of all existing utilities in the area of new construction. Exercise extreme care with all work adjacent to these utilities. A designated representative of the Contractor shall advise the Owner's Representative and Electrical Utility Provider where he can be contacted in any emergency.

B. Review drawings and notify the Engineer of any deviations in duct runs to avoid conflicts with existing utilities. Any changes in the work resulting in the same quantities of trenching material shall not entitle the Contractor to any claim for an addition to this Contract.

C. The Contractor is responsible for any damage done to existing utility installations during the course of the work. All damaged installations shall be replaced to the satisfaction of the utility or agency involved at the expense of the Contractor.

D. Comply with the Division 1 and 2 requirements for site work, including excavation, bracing and shoring, erosion control, requirements for temporary pumping equipment, backfilling, patching and paving, sod replacement, removal of surplus material, and requirements for traffic control

during construction.

PART 2 PRODUCTS

2.01 GENERAL

A. Naming of manufacturers indicates the manufacturer's brand name is acceptable only if their product is in compliance with each and every provision of this Specification. Failure to comply will result in disapproval.

B. Supplier and/or Electrical Contractor shall be responsible to ensure that material or equipment is of the same size, quality, capacity, weight, and electrical characteristics as that specified. The Contractor/Supplier shall pay any changes and costs required during construction due to Contractors/Suppliers neglect to properly select equipment.

C. Notify Owner's Representative for an on-site visit to inspect material and equipment prior to installation.

D. Materials and equipment shall be new, undamaged, and shall be UL listed for its use.

E. Defects and damages of material shall be replaced, furnish any new material as necessary and install the system at the Contractor's expense.

F. Furnish material and equipment samples when requested by the Owner's Representative, within 21-days of request.

G. Non-approved material and equipment must be removed from the jobsite.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting the performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 GENERAL

A. Conform to Division 01.

B. Provide conduit, wiring, and all components indicated on schedules and diagrams.

C. Before any installation, devices or equipment can be directed or located by the Owner's Representative within 20-feet of the designed contract location without extra cost.

D. Device or equipment mounting height given herein the Specifications, Contract Drawings, and/or documents are intended to provide general guidelines pursuant to industry standards. Such guidelines may not be exact or accurate and may or may not conflict with other trades installation without verification.

E. Provide field coordination and verification with other contractors, trades, or any shop drawings, and ensure that such mounting heights if indeed are practical and feasible as not to conflict with other installation and construction. If conflicts are discovered at any time during the construction, report to the Owner's Representative immediately for resolution.

F. If the Contractor fails to provide such coordination and field verification and results of erroneous installation, the Contractor shall remedy such installation per Owner's Representative direction, at Contractor's cost.

3.03 MANUFACTURER'S DIRECTIONS

A. Apply, install, connect, and erect manufactured items or materials according to the recommendations, wiring diagrams, instructions of the manufacturer when such recommendations are not illustrated or in conflict with the Contract Documents.

B. Furnish to the Owner's Representative on request, copies of manufacturer's recommendations. Secure approval of recommendations before proceeding with work.

C. Keep at the site not less than one copy, in good condition, of manufacturer's recommendations, wiring diagrams, instructions, or directions, pertaining to work at the site. Inform involved personnel of requirements and availability of manufacturer's recommendations.

3.04 UTILITY STANDARDS

A. All work associated with electrical power and telecommunications utilities shall be installed in accordance with the standards and specifications established by the serving utility.

B. Contact electrical power and telecommunications utilities. Verify and coordinate work scope prior to commencement of installation.

3.05 CONTINUITY OF BUILDING AND UTILITY SERVICES AND SHUTDOWNS

A. Continuity of utilities services in the building shall be maintained at all times as required to provide heat, water, lighting, and power to all portions of all buildings. Utility systems shutdowns required for extensions, alterations or connections of new services shall be accomplished in accordance with the following requirements.

B. Shutdowns: Utilities shutdowns shall be scheduled for weekends, holidays, or at night if the shutdown affects the use of the Owner's buildings. The actual time and date will be coordinated with, and approved by the Owner at least 72-hours in advance. Contractor shall be required to provide temporary power as required by the Owner to keep facilities operational during utility shutdowns.

C. Costs: Pay all costs associated with utilities shutdowns. No extra payment will be made for overtime work, schedule changes, or failure to complete utilities connections within authorized shutdown periods.

3.06 COORDINATION

A. The drawings are diagrammatic and indicate generally the locations of materials and equipment. These drawings shall be followed as closely as possible. Coordinate the work under this section with the architectural, structure, plumbing, heating and air conditioning, and the drawings of other trades for exact dimensions, clearances, and roughing-in locations. Cooperate with other trades in order to make minor field adjustments to accommodate the work of others.

B. Coordinate work with Ceiling Contractor so that above-ceiling work is completed, inspected and accepted by the Owner's Representative prior to ceiling installation.

C. Verify counter heights with cabinet installer and cabinet shop drawings, prior to rough-in for outlets. Unless otherwise indicated, outlets are to be mounted 6" (on center) above counter or backsplash. Existing outlets to be extended to match new outlet installation height. Verify height with Owner's Representative of any location that will not accommodate mounting heights.

D. Coordinate electrical work with mechanical installations. Connect power wiring to mechanical equipment through starters, contactors as required. Maintain clearances around mechanical equipment to allow access for maintenance per NEC codes and local codes.

E. Coordinate wiring interconnections for the complete operation of electrical-mechanical equipment to include items provided by other divisions. Examine equipment connection information with manufacturer's shop drawings and submittals.

F. Provide detailed wiring diagrams for equipment and component interconnection when requested by the Owner's Representative.

G. Verify with Mechanical Contractor for final mechanical equipment locations prior to work. Connect power wiring to mechanical equipment through starters, contactors, and VFDs as required.

H. Refer to project Construction Schedules. Schedule each specific area so that the delivery of materials and equipment are such as to cause no delay in Construction Schedules. Include the

premium cost of delivery of equipment and overtime work in order to comply with the Construction Schedule if necessary.

I. Coordinate and verify exact locations of wiring devices, light fixtures, fire alarm and communication devices and equipment prior to beginning of rough-in.

J. If directed by the Owner's Representative, the Contractor shall, without extra charge, verify with local inspectors or authorities having jurisdiction, and make reasonable modifications in the layout as needed to prevent conflict with work of other trades of for proper execution of the work.

K. If directed by the Owner's Representative, the Contractor shall, without extra charge, provide layouts of equipment and details of mounting method for review, prior to installation to ensure proper execution of the work.

3.07 RACEWAYS

A. One-line diagrams, risers, and conduit routing are schematic and are not showing exact physical arrangement of equipment or exact routing of conduit. Coordinate conduit routing with all other trades.

B. Where indicated on Drawings, junction boxes and pull boxes are minimum requirements. Provide other fittings and pull boxes of adequate size in the raceway system wherever necessary or required by the National Electrical Code. Allow a maximum of four-quarter bends between pull boxes in each run of conduits.

C. Provide expansion joint fittings for conduits passing through new or existing expansion joints installed between buildings. Verify exact locations and details of expansion joints prior to work.

D. Coordinate conduit routing, pull box and equipment locations with other trades to avoid conflicts of equipment installations.

E. All empty conduits shall have pull wires.

F. Provide unistrut mounting channels, hanger rods, anchor bolts and fittings to support conduits and pull boxes.

G. Work shall comply with National Electrical Code requirements.

3.08 MISCELLANEOUS

A. Support all conduits and equipment in accordance with the National Electrical Code and the International Building Code.

B. Cutting and Patching: Perform cutting and patching as may be necessary for the proper installation of the electrical work. Grout around raceway penetrations and fill anchor bolt holes or spalled areas. Core drill new penetrations through existing structural walls, ceilings, and floor slabs.

C. Cleanup: The premises must be kept free of accumulated materials, rubbish, and debris at all times. Surplus materials, tools, and equipment must not be stored at the building. At the completion of the job, equipment and fixtures shall be left clean and in proper condition for their intended use.

D. Trenching: Perform excavation and backfill as may be necessary for the proper installation of the Electrical work, unless noted otherwise on the Drawings.

E. Demolition: Electrical demolition shall be performed by the Electrical Contractor as indicated on Plans and other sections of the Contract Documents.

F. Installation Details: Prepare and submit to the Owner's Representative detail sketches indicating equipment installation information with locations and dimensions.

G. Tests: Test wiring and electrical equipment to verify absence of grounds and short circuits and verify proper operation, rotation, and phase relationship. Demonstrate operation of all equipment in accordance with the requirements of this Specification and the manufacturer's

recommendations. Perform tests in the presence of the Owner's Representative. Provide instruments and personnel required to conduct these tests.

3.09 DRAFT STOPS AND FIRE STOPS

A. Verify with Architectural Plans and to maintain the integrity of the draft stops whenever work requires penetration of these areas. Patch as required to maintain integrity of stops.

B. Maintain fire-resistance ratings of walls, partitions, floors, ceiling, or other fire separation barriers whenever work requires penetrations or openings for equipment. Provide and use approved methods and fire seal material and fitting to maintain the fire resistance rating. Provide approved fire rated enclosures of double gypsum wall board for electrical panels installed in fire rated walls to maintain the wall fire resistance rating. Where panels are semi-flush mounted, provide painted oak wood trim.

C. Locate devices horizontally a minimum of 2-feet apart on opposing sides of a fire separation wall to maintain fire rating of wall.

3.10 INSTRUCTION PERIODS FOR OWNER'S PERSONNEL

A. Scope: Following installation of work, have representatives of installation tradesmen conduct demonstrations and instruction periods to point out locations of servicing points and required points of maintenance to Owner's Representatives.

B. General Description of Instruction Periods: Each period shall include preliminary discussion, and presentation of information from maintenance manuals with appropriate references to Drawings; followed by tours of building areas explaining maintenance requirements, access methods, servicing and maintenance procedures, and equipment cleaning procedures, control settings and available adjustments.

C. Scheduling of Instruction Periods: Notice of Contractor's readiness to conduct such instruction and demonstration shall be given to Owner's Representative at least two (2) weeks prior to the instruction periods, and agreement reached as to the date at which the instruction periods are to be performed. Obtain approvals of proposed date prior to making final arrangements.

3.11 GENERAL ELECTRICAL CHECKS AND TESTING

A. Test wiring and electrical equipment to verify absence of grounds and short circuits and verify proper operation, rotation, and phase relationship. Upon request, demonstrate operation of all equipment in accordance with the requirements of this Specification and the manufacturer's recommendations. Provide instruments and personnel required to conduct these tests.

B. Checks are intended to begin upon completion of a component or equipment installation. Testing generally occurs later when systems are energized or nearing that point. Beginning system testing before full completion, does not relieve the Contractor from fully completing the system as soon as possible, including all construction checklists and may require retesting portions of the system once all components are fully functioning.

C. The check and test procedures and record forms shall contain the following:
   1. The Subcontractor(s) executing checks or tests.
   2. A list of the integral components being inspected and tested, equipment tag numbers, manufacturer, model number, pertinent performance information / rating data.
   3. Test equipment used.
   4. Construction checklists associated with the components, if any.
   5. Any special required conditions of the check or test for each procedure.
   6. Items, conditions or functions to be inspected, verified or tested, the checks and testing method given and a place provided with results recorded.
   7. Acceptance criteria (or reference by specific table where the acceptance criteria is found).
   8. For each procedure, list the technician performing check or test and company, witnesses of the tests and dates of tests.
   9. Sampling strategies used.

D. The test procedures for dynamic equipment like lighting controls, emergency generator or fire alarm shall contain more step-by-step procedures. The test procedures and forms for more static components like panelboards, switchgear, circuit breakers, transformers, etc., can be more checklist-like in format. For each piece of equipment, checks and test procedures and their documentation record forms may be different documents or combined in the same document, but checks and tests should be grouped.

E. At the Commissioning Authority's discretion, if large numbers or repeated deficiencies are encountered, the Contractor shall test and troubleshoot all remaining systems at issue on their own before commissioning with the Commissioning Authority will resume.

F. Sampling for Identical Units. When there are a number of identical units, at the Commissioning Authority's discretion, some or all procedures of a test for a piece of equipment or assembly may be omitted when these same tests on other pieces of identical equipment or assemblies were conducted without deficiency.

G. Common Testing Requirements:
   1. The following requirements apply to all electrical systems and features that are to be commissioned when referenced below. Tests shall:
      a. Verify functionality and compliance with the design intent for each individual sequence module in the sequences of operation. Verify proper operation of all control strategies, energy efficiency and self-diagnostics features by stepping through each sequence and documenting equipment and system performance. Test every step in every written sequence and other significant modes, sequences and operational features not mentioned in written sequences; including startup, normal operation, shutdown, scheduled on and off, unoccupied and manual modes, safeties, alarms, overrides, lockouts, and power failures.
      b. Verify all alarm and high and low limit functions and messages generated on all points with alarm settings.
      c. Verify integrated performance of all components and control system components, including all interlocks and interactions with other equipment and systems.
      d. Verify shutdown and restart capabilities both for scheduled and unscheduled events (e.g. power failure recovery and normal scheduled start/stop).
      e. When applicable, demonstrate a full cycle from off to on and no load to full load and then to no load and off.
      f. Verify time of day schedules and setpoints.
      g. Verify all energy saving control strategies.
      h. Verify that monitoring system graphics are representative of the systems and that all points and control elements are in the same location on the graphic as they are in the field.
      i. Verify operator control of all commandable control system points including proper security level access.
      j. When testing procedures for commissioned equipment are listed in NETA Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems the NETA test procedures shall be part of the testing requirements of this specification. Additional testing procedures may be listed in this Specification.

H. Common Acceptance Criteria:
   1. The following common acceptance criteria apply to all equipment, assemblies, and features:
      a. For the conditions, sequences and modes tested, the equipment, integral components and related equipment shall respond to varying loads and changing conditions and parameters appropriately as expected, according to the sequences of operation, as specified, according to acceptable operating practice and the manufacturer's performance specifications. Verify that equipment operates within tolerances specified in: governing codes, acceptance criteria contained in the construction documents, manufacturer's literature and according to good operating practice.

b. Systems shall accomplish their intended function and performance.
c. All safety trips shall require a manual reset to allow a system restart.
d. Resetting a manual safety shall result in a stable, safe, and predictable return to normal operation by the system.
e. Safety circuits and permissive control circuits shall function in all possible combinations of selector switch positions (hand, auto, inverter, bypass, etc.).
f. Other acceptance criteria is given in the equipment testing requirements articles or referenced standards.
g. Additional acceptance criteria will be developed by the Commissioning Authority when detailed test procedures are developed.
h. When testing procedures for commissioned equipment are listed in NETA Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems the NETA performance criteria shall apply.

I. Load Balancing:
1. Checks shall be made for proper load balance between phase conductors and make adjustments as necessary to bring unbalanced phases to within 15% of average load.
2. Record all circuit changes on as-built drawings.
3. Do not fabricate nameplates, or cover plate device labeling prior to load balance test and adjustments.

3.12 COMMISSIONING REQUIREMENTS

A. The equipment and systems referenced in this Section are to be commissioned per Division 01. The Contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION

SECTION 26 05 01
BASIC MATERIALS AND METHODS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 GENERAL

A. Conform to General Conditions, Supplementary Conditions, Division 01, Division 26, Division 27, and Division 28.

B. Review the Specifications and Drawings for coordination with additional requirements and information that applies to work under this Specification.

1.02 SUMMARY

A. Devices, material, equipment, enclosures, and assemblies shall be new, UL listed, approved, and suitable for its environment where used.

B. Unless noted otherwise, wiring systems shall be installed in a complete raceway system.

C. Determine the exact electrical requirements of equipment from the equipment suppliers prior to rough-in.

D. All installations shall comply with ADA requirements.

1.03 REFERENCES

A. National Fire Protection Association (NFPA) – www.nfpa.org:
   1. NFPA 70 – National Electrical Code.
   2. NFPA 70E – Standard for Electrical Safety in the Workplace.

B. International Code Council – www.iccsafe.org:
   1. IBC – International Building Code.
   2. IFC – International Fire Code.

C. National Electrical Manufacturers Association (NEMA).

D. Underwriters Laboratories (UL).

1.04 EQUIPMENT FINISH

A. Electrical equipment, control panels, and cabinets, shall be furnished factory painted in the manufacturer’s standard colors unless otherwise specified.

B. Unfinished materials and equipment except conduit, shall be cleaned, primed and painted by the Electrical Contractor as directed by the Owner’s Representative in accordance with the Painting Section of the Specifications.

C. The colors of exposed electrical materials and apparatus shall be as selected by the Owner’s Representative.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer’s product data, installation instructions, use limitations and recommendations for each material used. Provide certifications stating that materials comply with requirements.

1.06 QUALITY ASSURANCE

A. Source: For each type of material required for the Work of this Section, provide primary materials which are the products of one manufacturer. Provide secondary materials which are acceptable to the manufacturers of the primary materials.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and products in unopened factory labeled packages. Store and handle in strict compliance with manufacturer’s instructions and recommendations. Protect from damage.

B. Make all necessary provisions for storing materials and equipment at the site to insure the quality and condition of the material to be installed. Utilize only new materials which are free of defects and which arrive at the jobsite unopened in the original container.

1.08 COORDINATION

A. Coordinate location of raceways, supports, cable trays and electrical equipment with other trades.

B. Determine the exact electrical requirements of all equipment from the equipment suppliers prior to rough in wiring. Refer any discrepancy between the Drawings and equipment requirements to the Architect for resolution prior to installation.

C. Construction Observation: Advise the Architect at least two (2) full working days prior to the covering of concealed electrical work.

PART 2 PRODUCTS

2.01 GENERAL

A. Furnish all items of the materials, design, sizes, and ratings specified herein.

B. All devices, equipment, enclosures, and material shall be UL listed, Engineer approved, and suitable for its environment where used.

2.02 RACEWAYS AND FITTINGS

A. All raceways shall be 3/4" minimum.

B. 3/4" raceways shall have no more than six (6) #12 AWG conductors.

C. Minimize the use of flexible metallic conduit. Flexible conduit shall only be used for light fixture connections, interior equipment connections, expansion and seismic joints, and sound control. Flexible metallic conduit shall not be used in concealed locations.

D. Electrical Metallic Tubing (EMT): Hot dipped galvanized or sherardized steel. Utilize compression type with insulated throat in interior locations and steel rain tight type in exterior locations. Cast metal shall not be used.

E. Rigid Galvanized Steel (RGS): Rigid metal conduit shall be galvanized steel type. Conduit fittings and accessories shall be listed for use with RGS.

F. Polyvinyl-Chloride (PVC): Rigid PVC conduit shall be used in ductbanks and encased in concrete where noted on Drawings.

G. Flexible Steel Conduit: Interlocking single strip, hot-dipped galvanized or sherardized, liquid-tight when used in wet or damp locations. Fittings shall be screw wedge type or liquid-tight type depending on conduit type used. Provide grounding fittings for ground wire installation outside conduit.

H. Concealed raceways shall be secured with heavy-duty, single-hole, steel straps. Nail-in style straps shall not be used.

I. Exposed raceways shall be secured with heavy-duty, two-hole, steel straps.

J. Exposed raceway running on roofs, surface mounted on building exterior within 10-feet of ground, walkways or stairs, exposed to weather or under covered walkways shall be galvanized rigid steel on rubber support pads with strut straps (not wood).

K. Raceways shall be supported independently from the ceiling suspension system, cable trays, ducts, and piping.

L. Pendant mounted groups of raceways shall be supported by 1-5/8” square preformed channel (Unistrut).

M. Cap or plug the ends of below grade conduits to prevent concrete and other materials from obstructing conduits.

N. Wherever buried, non-metallic, conduit passes through an expansion or contraction joint, or where required to compensate for thermal expansion and contraction, provide a conduit expansion joint. Install the conduit to cross the joint at right angles.

O. Pull Wires: Provide a pull wire in all empty raceways:
   1. Use nylon pull-wires of tensile strength not less than 240-pounds in each conduit and duct, leave pull-wires in ducts and conduit after cleaning.
   2. No splices in pull-wire will be allowed.
   3. Leave ample slack length at each end of pull-wire.

2.03 PATHWAYS FOR LOW-VOLTAGE SYSTEMS

A. Provide a complete pathway system for all low-voltage wiring. Pathways shall consist of “open” cabling supports (D-rings, J-Hooks, etc.), cable tray, or a combination of both. The extent of the cable tray shall be coordinated with the Owner’s Representative.

B. Pathways shall not include inaccessible spaces, unless a continuous conduit is provided through such spaces.

C. Provide a pull wire in all empty raceways.

D. Open Cable Supports:
   1. Where cables are to be installed as “Open Cabling”, cable supports (D-rings, J-hooks, adjustable straps and saddles as appropriate) shall be installed to allow cabling to be grouped and run along a common path. Cables shall be run parallel or at right angles to the building structure, and shall not be looped diagonally across the ceiling space. Cables shall be loosely bundled with cable ties at a minimum every 36” O.C.
   2. J-Hooks: Shall comply with TIA requirements for structured cabling system, and have a galvanized finish; Caddy #CAT21 with CATHBA angled hanger bracket or equal. Follow manufacturer’s recommendations for quantity of cables supported.
   3. Cable Tray:
      a. Provide 18” wide x 4” deep aluminum ladder style cable tray with 9” rung spacing in all major corridors or as shown in Drawings.
      b. Provide longitudinal and lateral seismic bracing.
      c. All penetrations through rated walls shall be firestopped with removable, re-enterable fire stopping system. Fire stopping shall be the responsibility of the Electrical Contractor, not the individual low-voltage subcontractor(s). All conduits/penetrations should be sealed prior to ceiling cover inspection.
   4. Ground all cable trays as required per NEC.
   5. Do not run cable tray through rated walls or floors. Provide multiple 4-inch raceway sleeves through rated walls and floors to simplify fire stopping.

2.04 RACEWAY SLEEVES (FIRE-STOP DEVICES)

A. Provide raceway sleeves as required or as indicated on Drawings for low-voltage cabling through walls and floors. Sleeves shall be Hilti model CP-653 or approved equal. Provide diameter size as required. Sleeves shall have the following features at a minimum:
   1. Shall be re-penetrable, high capacity cable management devices for low-voltage cable routing.
   2. Shall have the ability to re-penetrate from one side of the wall.
   3. Shall have 100% visual fill.
   4. Can be installed in wall and floor applications.
   5. Fire-rated for up to 3-hours in concrete and fire-rated up to 4-hours for gypsum walls.

2.05 WIRE AND CABLE

A. Branch circuit wiring shall be #12 AWG copper minimum unless indicated otherwise. Conductors #10 AWG and smaller shall be solid copper with Code grade insulation and a minimum temperature rating of 75 deg C.

B. Branch circuit ground wire, isolated ground wire, equipment grounding conductor and grounding electrode conductors shall be insulated the same as the circuit or feeder conductors.

C. Conductors #8 AWG and larger shall be stranded copper, with Code grade insulation and a minimum insulation temperature rating of 75 deg C, and connected to equipment by means of compression type terminal lugs. Compression lugs shall be hydraulic compression only. Mechanical compression methods are not acceptable. Provide two-hole lugs of AL/Cu type only. Single hold lugs are not acceptable.

D. Marking: Wire must be marked at 2' intervals with gauge, insulation type, and manufacturer. Label feeders at each end of phase designation.

E. Low voltage wiring and cables specified herein by Divisions 26, 27, or 28 shall be installed either in complete raceway system or shall be plenum rated.

2.06 JUNCTION AND PULLBOXES

A. Manufacturers: Bower, Raco or Steel City. Boxes exposed to weather shall be Crouse Hinds or approved equal cast aluminum type.

B. Electrical boxes shall conform to UL-50, "Standard for Electrical Enclosures" and UL-514, "Standard for Electrical Outlet Boxes and Fittings".

C. Provide electrical boxes of the material, finish, type, and size indicated and required for the location, kind of service, number of wires, and function.

D. Electrical boxes that are shown on the Drawings with no indication of size shall be provided in accordance with the NEC.

E. Junction boxes, pull boxes, and outlet boxes shall be pressed steel with knockouts and matching cover as required with size, depth, and shape best suited to the location and intended service. Cover on finish area shall be provided with specification grade quantity type to match finish surface. Include plaster or tile rings as required.

F. Provide neoprene gaskets 1/8" thick with all boxes subjected to weather.

G. Grounding: Provide each box with a grounding terminal.
   1. Grounding Terminal: Either a green-colored washer-in-head machine screw not smaller than 10-32 in a drilled and tapped hole in the back of the box or a grounding bushing with green-colored machine screw terminal attached to one of the conduits.
   2. Install grounding jumpers as specified in 26 05 26 "Grounding and Bonding".

2.07 SUPPORTING DEVICES

A. Provide dedicated blocking and support method to ensure secure installation of all device boxes such that the installation is capable of withstanding a minimum 50-pound pulling force without moving.

B. Support raceway by straps, suitable clamps or hangers to provide a rigid installation. Perforated strap hangers and twisted wire attachments will not be acceptable. Do not support or fasten raceways to other pipe or in a manner to prevent the ready removal of other pipe.

2.08 GROUNDING

A. Conform to NEC Article 250.

B. Ground Wire: Color coded green, copper conductor, with insulation same as circuit or feeder conductors.

C. Grounding Conductor: Provide green insulated equipment grounding conductor or circuit grounding conductor per NEC 250 in raceway system. Insulation and conductor type shall be the same as circuit conductors.

PART 3 EXECUTION

3.01 RACEWAY

A. IMC and EMT: Interior areas.

B. RGS: Exterior area with approved weatherproof fittings.

C. PVC: Exterior underground with RGS factory-radius elbows transitioning above ground.

D. Flexible Conduit: Flexible metal conduit located in wet locations, mechanical room, kitchen areas, shall be liquid-tight type. A maximum of 72” of flexible metal conduit shall be used for the connection to motors and vibrating equipment, final connection to lay-in light fixtures. Flexible metal conduit shall be continuous grounding type and provide with grounding lug per spec. No flexible conduit allowed for any concealed installation.

E. Minimum Sizes: Conduit sizes are not necessarily specified on Drawings. Provide a minimum 3/4" conduit homeruns and multi-pole circuits. Refer to other specification sections for other minimum sizes. Contractor shall provide sizing of conduits as required to meet code where the above specified minimum sizes are too small to afford 40% fill. Conduit sizes shall be sized for conductor types and sizes per NEC.

F. Conduit termination shall have code-sized junction box for flush or surface installation. Conduit stubs shall have nylon insulated type bushing.

G. Pull Wires: Provide pull wires in all empty raceways. Pull wires shall be continuous in each raceway run and extend a minimum distance of 12” from the junction box or terminal at the end of the raceway.

3.02 INSTALLATION

A. One-line diagrams, risers, and conduit routing are schematic and do not show exact arrangement of equipment.

B. Where indicated on Drawings, junction boxes and pull boxes are minimum requirements. Provide other fittings and pull boxes of adequate size in the raceway system wherever necessary or required by the NEC. Allow a maximum of four 90-degree bends between pull boxes in each run of conduit.

C. For root-top conduit installation, provide expansion joint fittings and Firestone rubber blocking (to match existing where applicable) and assemblies.

D. Provide expansion joint fittings for conduits passing through new or existing expansion joints. Verify exact locations and details of expansion joints prior to work.

E. Coordinate conduit routing, pull box and equipment locations with other trades to avoid conflicts of equipment installations. Empty conduits shall have pull wires.

F. Conceal all raceways except as permitted by Architect.

G. Where permitted, exposed raceway shall be run parallel or perpendicular to the building. Run raceways as high as possible, unless noted otherwise.

H. Carefully form bends to avoid injuring or flattening raceway. Raceways 1-inch trade size and larger shall utilize factory formed fittings where bends are 45-degrees or larger. Minor offsets are permitted to be filed bent. All bends in conduits serving low-voltage systems shall not have bend radii less than 10-times the nominal conduit size.

I. Support raceways with heavy-duty, one-hole, pressed steel straps on interior surfaces. Support pendant mounted raceways on 1/4" rod with pear-shaped hanger (up to 2” pipe size) or trapeze type hanger with 3/8” rod, 1-5/8” square preformed channel. Conduit support system shall be dedicated and isolated from other systems and ceiling supports or tees. Conduit installations shall not use ceiling type wire and clips as support system.

J. Anchor all electrical work securely to structure using fasteners approved by a Washington State Licensed Structural Engineer for the types of structure encountered.

K. Anchor to frame structure by means of sheet metal screws. Fasten to structural walls with lead anchors or steel expansion shells and threaded bolts or screws with slotted heads. Fasten to

architectural or masonry walls with toggle bolts or molley screws. Deviation from these methods must be approved prior to installation.

L. Furnish anchor bolts and anchorage items as required, and field check to insure proper alignment and location. Provide templates, layout drawings, and supervision at the job site to ensure correct placing of anchorage items in concrete. Check embedded items for correctness of location and detail before concrete is placed.

M. Control erection tolerance requirements to not impair the strength, safety, serviceability, or appearance of installations, as approved by the Engineer. Determine exact location of conduit. Route all conduit parallel to building lines.

N. Hot-dip galvanize all exterior support hardware after fabrication.

O. Install individual conductors in conduits, raceways, ducts, and trenches to complete the wiring systems.

P. Install switches and cover plates complete in a neat manner in accordance with the NEC and local codes.

3.03 WIRE AND CABLE

A. Branch circuits shall be #12 AWG minimum.

B. Branch circuit wiring size #10 AWG and smaller shall have continuous color code identification per standard listed below. Tin all stripped ends of wiring #10 AWG and smaller prior to termination under set screws.

C. Use no mechanical means for pulling wires, and no lubricant except powdered soapstone or approved substitute.

D. Branch circuit splices may be made with 3M Scotch-Lok Electrical Spring type connectors up to #8 AWG size, except motor connections.

E. Utilize crimp-type pressure connectors insulated with tape or pre-fabricated covers on motor connections and splices of wiring #6 AWG and larger.

F. Make no splices in home runs.

G. Do not inter-mix wiring from separate raceway systems unless specifically permitted by the Engineer.

H. Color Coding Standards:

3Ø, 4 Wire System:	208Y/120V	480Y/277V
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green

Control Wiring: Grey or black with identifying wire numbers at each termination

Color-coded Tape: May be used in lieu of color-coded insulation for conductors #8 AWG and larger. However, the insulation shall be black only and shall be tape-identified with color scheme shown above at splices, terminations and junction boxes.

I. Each single pole branch circuit shall contain a dedicated neutral conductor and equipment grounding conductor of the same size as the hot conductors. Shared neutral conductors and/or multi-pole breakers used on single pole loads are not permitted.

J. All wiring shall be identified with permanent wire labels, using alphanumeric designations. All terminations and splices shall be identically labeled for the same wire (i.e. common conductors terminated in multiple locations). Wire labels shall agree with the circuit designations on the as-built drawings. Provide Thomas and Betts, Brady, or equal, printed plastic adhesive tapes to show circuit numbers. Wrap tapes at least two turns around conductor.

K. Identify conductors in outlets, pullboxes, and similar locations where conductors are accessible.

L. Conductors in panels, cabinets, and enclosures: Provide neat and workmanlike installation with conductors tied with T&B Ty-Rap, or equal, nylon wire ties. Provide adhesive back nylon Ty-Rap 4-way bases (#TC200X200AX or equal) to group conductors in neat and orderly manner.

M. Low voltage wiring and cables specified herein by Divisions 26, 27, or 28 shall be installed either in complete raceway system or shall be plenum rated.

3.04 WIRING DEVICES

A. Installation: Install two or more wiring devices shown in one location under a common plate. Install plates with edges in continuous contact with finished wall surfaces. Do not install more than one device in single-gang position.

B. Device Locations: Device or equipment mounting height given herein the Specifications, Contract Drawings, and/or documents are intended to provide general guidelines. Provide pre rough-in coordination and verification with other divisions. Verify that the intended mounting heights are appropriate for the intended device use, and the device location is not in conflict with other components.

C. Prior to rough-in, devices and equipment locations may be revised by the Owner's Representative within 20' of the designed contract location, at no cost. Prior to rough-in, confirm locations with Owner for devices they may wish to have relocated from the location indicated on the contract drawings.

D. If the contractor fails to provide such coordination and field verification and results of erroneous installation, the contractor shall remedy such installation per Owner Representative's direction, at contractor's cost.

E. Provide GFCI protection for receptacles requiring GFCI protection per NEC Article 511.

F. Mount wiring devices above finished floor to centerline of device as follows, unless noted otherwise or as directed by Owner's Representative. Coordinate with Owner's Representative for possible interference with decorative features, art displays, etc.

Switches	42-inches
Receptacles, Telecom Outlets	18-inches
Receptacles Above Counter	6-inches to CL above backsplash or as directed
Fire Alarm Pull Stations, Wall Phones	42-inches
Fire Alarm Audio Visual Devices	80-inches (or 6" below ceiling), whichever is lower
Receptacles (in Classified Areas)	24-inches (above finished floor and below ceiling)

3.05 BOXES

A. Support boxes securely and independently.

B. Mount boxes on building surfaces or support with trapeze hanger.

C. Do not use junction boxes unless the number of bends, pulling length or circuit requirement necessitates their installation.

D. Junction or pull box openings must be accessible.

E. Do not use extension rings to provide Code size space within a new junction box. Provide larger junction boxes as required in lieu of extension rings.

F. Do not intermix raceways and wiring at common junction boxes except at terminal equipment connections.

3.06 GROUNDING

A. General: Provide system and equipment grounding in accordance with the applicable codes and ordinances and as further amplified on the Drawings.

B. Ground service equipment, separately derived systems, conduits, devices and equipment in accordance with NEC, Article 250.

C. Grounding Conductor: Provide green insulated equipment grounding conductor in conduits containing wiring systems above 50 volts. Insulation and conductor type shall be the same for circuit or feeder conductors. Size conductors in accordance with NEC Article 250.

D. Bonding: All conduit systems shall be effectively grounded and bonded together by approved bonding means in accordance with the NEC. Verify ground continuity between conduits, boxes, receptacles, and equipment.

E. Inspection: Place no backfill around grounding system until it has been inspected by the Engineer, Electrical Inspector, and Owner's Representative.

END OF SECTION

SECTION 26 05 02
MINOR ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

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

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify field measurements and circuiting arrangements are as shown on Drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation.

D. Report discrepancies to Owner's Representative and Owner before disturbing existing installation.

E. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings to be removed.

B. Coordinate utility service outages with utility company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.

1. Make temporary connections to maintain service in areas adjacent to work area.

3.03 TEMPORARY ELECTRICAL POWER

A. Temporary Electrical Power shall comply with Division 01.

B. Continuity of Service: Provide temporary service to existing systems as required to maintain continuous operation without reducing equipment efficiency. Coordinate the extent of temporary services with the Owner Representative.

C. Power Outages: refer to 06 2020 Work sequence specification for allowable outage requirements..

D. Contractor shall provide temporary power throughout Construction Sequences such that no building is without power during occupied periods of time. Coordinate sequences and scheduling with the Owner Representative.

E. Contractor shall be responsible to ensure the Owner's Representative facilities are operational during construction sequences. Coordinate all temporary outages at least 1-week in advance with Owner and Architect.

F. Costs: Pay all costs associated with temporary power and utility shutdowns. No additional payment will be made for overtime work, schedule changes, or failure to complete temporary connections and/or permanent service connections within authorized shutdown periods.

3.04 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Remove, relocate, and extend existing installations to accommodate new construction.

B. Identify circuit source of supply to outlets and equipment effected by demolition.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.

F. Maintain continuity to existing outlets and equipment scheduled to remain. Provide additional raceway, boxes and wire required to restore existing circuitry.

G. Disconnect and remove abandoned panelboards and distribution equipment.

H. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

I. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

J. Repair adjacent construction and finishes damaged during demolition and extension work. Restore finishes to same quality before demolition work commenced.

K. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

L. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.05 CLEANING AND REPAIR

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

END OF SECTION

SECTION 26 05 13
MEDIUM VOLTAGE CABLES

PART 1 GENERAL

1.01 GENERAL

A. Conform to General Conditions, Supplementary Conditions, Division 01, and Division 26.

B. Review the Specifications and Drawings for coordination with additional requirements and information that applies to work under this Specification.

1.02 SECTION INCLUDES

A. Medium voltage cable.

B. Cable terminations.

1.03 RELATED REQUIREMENTS

A. Section 26 05 41 – Underground Electrical Construction.

B. Section 26 05 53 – Identification for Electrical Systems.

C. Section 26 11 16 – Secondary Unit Substations.

D. Section 26 12 16 – Substation Transformers – Dry-Type.

E. Section 26 13 16 – Medium Voltage Switches.

1.04 SUBMITTALS

A. See Division 01, Section Administrative Requirements, for submittal procedures.

B. Product Data: Provide for cable, terminations, and accessories.

C. Certification: Names and certification of cable splicing/termination personnel. See 1.5 below for additional requirements.

D. Test Reports: Cable test reports prior to connection of any cables to equipment.

E. Samples: Submit two samples of each size cable, 24 inches (600 mm) in length.

1. Select each length to include complete set of manufacturer markings.
2. Attach tag indicating cable size and application information.

1.05 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Manufacturer’s Qualifications: Company specializing in manufacturing the products specified in this section with minimum five (5) years documented experience and with service facilities within 100 miles (160 km) of Project.

C. Installer Qualifications: Authorized installer of specified manufacturer with service facilities within 100 miles (160 km) of Project, and minimum five (5) years documented experience. Provide documentation stating experience with similar projects and with minimum three references.

D. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Southwire Company: www.southwire.com

B. The Okonite Company: www.okonite.com

C. Or other reviewed and approved Manufacturers.

2.02 GENERAL

A. All materials and equipment shall be new, undamaged, and shall be UL listed for its use.

B. All defects and damaged material shall be replaced with new material as necessary and installed at Contractor's expense.

2.03 MEDIUM VOLTAGE CABLE

A. Cable shall be single-conductor ethylene-propylene rubber (EPR) insulated rated for 15kV phase-to-phase (max.) at temperatures up to 105 degrees C for continuous operation. Cable shall be approved for wet or dry locations, in conduit or directly buried.

B. Conductor shall be Class B stranded, annealed, uncoated copper (No. 2/0 American wire gauge) and rated ampacity of 200 amperes or more at 15kV when installed in conduit underground (one circuit). The conductor shall be completely covered with an extruded layer of semi-conducting material firmly bonded with both the conductor and the insulation but easily strippable from the conductor.

C. Directly over this conductor shield shall be a 220 mil homogenous layer of crosslinked polyethylene insulation. Minimum insulation thickness at any point in the cable shall be 200 mils.

D. Insulation shielding shall be provided and shall be a uniform extruded layer of semi-conducting EPR nominal 30 mils. A 5 mil helically applied copper shielding tape shall be applied with a minimum 10% overlap.

E. An overall jacket shall next be applied consisting of nominally 80 mils of PVC. Minimum jacket thickness shall be 65 mils. Jacket shall be permanently imprinted with manufacturer's name, conductor size, insulation type, voltage rating and any other industry standard markings.

F. Cable shall be ordered with sealed ends which shall be checked immediately upon arrival from the manufacturer. Finding a defective seal, the cable shall not be accepted for installation on this project.

G. Cable shall be delivered with manufacturer's test report evidencing satisfactory operation of the cable at an applied DC voltage of five times the rated cable voltage for a period of 15 minutes and less than 10 pico-coulombs (max) or 5 pico-coulombs nominal corona discharge at an AC test of 4 times rated voltage.

H. Cable shall be listed under UL 1072 MV105.

I. Ground grid and grounding electrode conductors shall be soft drawn, minimum 95% conductivity, copper, bare, stranded in accordance with UL standards.

2.04 ACCESSORIES

A. Terminators and Connectors:

1. Terminators for connection of underground medium-voltage cables shall be one piece silicone rubber cold shrink molded type with integral stress relief tube. Terminator shall be specifically designed for the cable type and size in use.
2. Connectors at transformers and electrical vaults shall be 200A 15kV loadbreak rated elastomeric type elbows. Connectors shall be specifically designed for the cable type and size in use. Units shall be rated 95kV BIL and shall be provided with stress relief adaptor, spade terminal, conductive shield, voltage test point with cap and auxiliary cable shield grounding device as recommended by the manufacturer. Connectors shall be submersible.
3. Load break elbows shall be Elastimold Division of Thomas & Betts. Load break elbows shall be furnished with test point and trip indicator.

B. Load Break Junctions:

1. Four point load break type, for use on grounded or ungrounded systems with maximum phase-to-ground voltage of 8.3 kV.
2. BIL: 95 kV, 200A RMS continuous, 10,000A, RMS SYM, short time (0.2 sec).
3. Elastimold #K1601WJ4, or approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conduit, duct, trench, or manholes are ready to receive cable.

B. Verify that field measurements are as indicated.

C. Verify routing and termination locations of cable bank prior to rough-in.

D. Cable routing is shown in approximate locations unless dimensioned. Route as required to complete wiring system.

3.02 EXCAVATION

A. Conform to Division 03, Earthwork Specification, for all requirements.

3.03 BACKFILLING

A. Conform to Division 03, Earthwork Specification, for all requirements.

3.04 PREPARATION

A. Use swab to clean conduits before pulling cables.

3.05 MEDIUM VOLTAGE CABLE

A. Medium voltage cable shall be carefully installed in duct provided under this project in accordance with manufacturer's recommendations. Pulleys used for installation shall be the largest diameter possible. Care shall be taken not to exceed manufacturer's suggested maximum pulling tension.

B. The Contractor shall submit a certification, to and for the approval of the Engineer, that contains the names and qualifications of persons recommended to perform the splicing and termination of medium-voltage cables approved for installation under this contract. The certification shall indicate that persons recommended to perform actual splicing and terminations have been adequately trained in the proper techniques and have had at least 5 recent years of experience in splicing and terminating the same or similar types of cables approved for installation. In addition, persons recommended by the Contractor may be required to perform a dummy or practice splice and termination, in the presence of the Engineer, before being approved as a qualified installer of medium-voltage cables. The Contractor shall provide short sections of the approved types of cables along with the approved type of splice and termination kits, and detailed manufacturer's instructions for the proper splicing and termination of the approved cable types.

3.06 INSTALLATION

A. Avoid abrasion and other damage to cables during installation.

B. Use suitable lubricants and pulling equipment.

C. Sustain cable pulling tensions and bending radii below recommended limits.

D. Ground cable shield at each termination and splice.

E. Arrange cable in manholes to avoid interference with duct entrances.

F. Fireproof cables in manholes using fireproofing tape in half-lapped wrapping. Extend fireproofing 1 inch (25 mm) into duct.

3.07 GROUNDING

A. The following shall be securely grounded in accordance with the Drawings and Specifications:

1. Cable shields.
2. Cable terminations and splices.
3. Metallic conduits.
4. Pad-mounted transformer and enclosure.
5. Cable racks.
6. Manholes and covers.

B. In addition, any other exposed non-energized metallic parts and/or equipment shall be grounded.

C. Unless otherwise indicated, all grounding conductors shall be AWG #2 copper stranded. Ground conductors shall be attached to all metallic items with hydraulically applied compression fittings designed to be bolted in place. Termination at ground rods shall be attached with appropriately configured hydraulically applied compression fittings.

D. Maximum ground resistance of 10 ohms shall be provided by supplementing the grounding methods specified herein as required. Ground resistance shall be measured in normally dry conditions at least 48 hours after install.

E. Fusion welding shall not be used on this project. Ground system connections/terminations shall be hydraulically applied compression fittings only.

F. Cable shields shall be individually connected to a #4 copper grounding conductor of a length of at least 24”. Groups of #4 copper grounding conductors may be made and extended to grounding points with a #2 copper grounding conductor. The intent of the above is to allow freedom of movement of each cable.

G. Cable termination equipment/devices shall be grounded as above either separately or in combination but still providing the freedom of movement for each cable.

H. Metallic conduits shall be grounded using metallic grounding bushings or universal ground clamps. Grounding conductor shall be #2 copper and shall extend to the nearest ground point.

I. All ground connections shall be compression type and shall be accessible.

J. All ground rods shall be 5/8 inch x 8 feet copper clad steel ground rods.

K. Transformer station grounding shall be accomplished by installation of a #4/0 bare copper grounding grid as follows:

1. Drive (1) 5/8 inch x 8 feet copper clad steel ground rod such that when the installation is complete, this ground rod extends 3 inches above the vault floor under the high voltage compartment.
2. Drive (1) 5/8 inch x 8 feet copper clad steel ground rod similar to the above except under the low voltage compartment.
3. Drive (1) 5/8 inch x 8 feet copper clad steel ground rod at each of the four corners of the transformer pad, 6 inches outside the concrete pad edge to a depth such that the top of each ground rod is approximately 6 inches below finished grade.
4. Provide a #4/0 bare, stranded copper conductor connecting the corner ground rods together in a rectangular pattern approximately 6 inches outside the concrete pad edge. Provide another #4/0 bare stranded ground conductor connecting this ground girdle to the ground rods under the high and low voltage cable terminating compartments. Connect the conductors to the ground rods using bolted or compression type connectors with the connections made at the elevation between natural earth and gravel subbase.

3.08 LOADBREAK JUNCTIONS

A. Install in accordance with manufacturer’s instructions in location indicated.

3.09 LOADBREAK ELBOW CONNECTIONS

A. Provide Raychem #ESA elbow shrink seals at all terminations.

B. Install elbows in accordance with manufacturer’s instructions.

3.10 TESTING

A. Medium voltage cables shall be individually tested after installation and termination but before the cable terminator is actually connected to any apparatus. The DC high potential test shall be made from conductor to ground at five times rated cable voltage for a period of 15 minutes.

B. Test parameters shall be recorded on an approved form. Parameters shall be noted after each minute of the test. Parameters to be recorded include:

1. Cable identification.
2. Cable type and ratings.
3. Cable size.
4. Phase.
5. Applied voltage.
6. Leakage current.
7. Calculated impedance.
8. Ambient temperature.

C. Contractor shall notify Owner's Representative and Architect/Engineer at least one week in advance of the dates when the above testing will be undertaken.

D. In the presence of the Owner's Representative and Engineer, the Contractor shall demonstrate that the cables are properly identified by an approved method at both ends.

E. Upon completion of the cable testing, the Contractor will energize the system and demonstrate proper operation of all equipment and materials in the presence of the Owner's Representative.

F. Apparatus arranged for manual operation shall be operated under power then returned to their 'normal' condition.

G. Instruments, gauges, testing equipment, hot-sticks, protective and safety equipment for all testing shall be provided by the Contractor. Energy for the tests shall be provided by the Owner.

3.11 FIELD QUALITY CONTROL

A. Perform field inspection in accordance with Division 01.

B. Inspect exposed cable sections for physical damage.

C. Inspect cables for proper connections as indicated.

D. Inspect shield grounding, cable supports, and terminations for proper installation.

3.12 PROTECTION

A. Protect installed cables from entrance of moisture.

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 GENERAL

A. Conform to General Conditions, Supplementary Conditions, Division 01, Division 26, and Division 27.

B. Review the Specifications and Drawings for coordination with additional requirements and information that apply to work under this Specification.

1.02 SUMMARY

A. Section Includes:

1. Copper building wire rated 2000 V or less.
2. Aluminum building wire rated 600 V or less.
3. Metal-clad cable, Type MC, rated 2000 V or less.
4. Armored cable, Type AC, rated 600 V or less.
5. Photovoltaic cable, Type PV, rated 2000 V or less.
6. Mineral-insulated cable, Type MI, rated 600 V or less.
7. Tray cable, Type TC, rated 2000 V or less.
8. Fire-alarm wire and cable.
9. Connectors, splices, and terminations rated 2000 V and less.

1.03 DEFINITIONS

A. PV: Photovoltaic.

B. RoHS: Restriction of Hazardous Substances.

C. VFC: Variable-frequency controller.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Data: For solvents and adhesives, indicating VOC content.
3. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

C. Product Schedule: Indicate type, use, location, and termination locations.

1.05 INFORMATION SUBMITTALS

A. Qualification Data: For manufacturer’s authorized service representative.

B. Field quality-control reports.

1.06 QUALITY ASSURANCE

A. All wire and cable shall be new.

B. Listing and Labeling: Provide wire and cable that are Listed and Labeled as defined in NFPA 70, Article 100 and marked for specific types, sizes, and combinations of conductors and connected items.

C. Comply with NFPA 70.

D. Testing Agency Qualifications: Member company of NETA.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

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

B. Single-Source Responsibility: All conductors and cable of each type shall be the product of a single manufacturer.

2.02 COPPER BUILDING WIRE

C. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 2000 V or less.

D. Basis-of-Design Product: Subject to compliance with requirements, provide Service Wire Co. or a comparable product by one of the following:
   1. Alpha Wire Company.
   2. American Bare Conductor.
   3. Belden Inc.
   4. Cerro Wire LLC.
   5. General Cable Technologies Corporation.
   6. Okonite Company.
   7. Southwire Company.
   8. WESCO.

E. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. RoHS compliant.
   3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide".

F. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

G. Conductor Insulation:
   1. Type NM: Comply with UL 83 and UL 719.
   2. Type RHH and Type RHW-2: Comply with UL 44.
   3. Type USE-2 and Type SE: Comply with UL 854.
   4. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
   5. Type THHN and Type THWN-2: Comply with UL 83.
   6. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
   7. Type UF: Comply with UL 83 and UL 493.
   8. Type XHHW-2: Comply with UL 44 and dual rated for 600 volt and 1,000 volt.

2.02 ALUMINUM BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Basis-of-Design Product: Subject to compliance with requirements, provide Service Wire Co. or a comparable product by one of the following:

1. Alpha Wire Company.
2. American Bare Conductor.
3. Belden Inc.
4. Cerro Wire LLC.
5. General Cable Technologies Corporation.
6. Okonite Company.
7. Southwire Company.
8. WESCO.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide".

D. Conductors: Aluminum, complying with ASTM B800 and ASTM B801.

E. Conductor Insulation:

1. Type NM: Comply with UL 83 and UL 719.
2. Type RHH and Type RHW-2: Comply with UL 44.
3. Type USE-2 and Type SE: Comply with UL 854.
4. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
5. Type THHN and Type THWN-2: Comply with UL 83.
6. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
7. Type XHHW-2: Comply with UL 44.

2.03 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath, rated 600 V.

B. Basis-of-Design Product: Subject to compliance with requirements, provide Service Wire Co., or a comparable product by one of the following:

1. AFC Cable Systems; a part of Atkore International.
2. Alpha Wire Company.
3. American Bare Conductor.
4. Belden Inc.
5. General Cable Technologies Corporation.
6. Okonite Company.
7. Southwire Company.
8. WESCO.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. RoHS compliant.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire

and Cable Marking and Application Guide".

D. Circuits:
   1. Single circuit and multicircuit with color-coded conductors.
   2. Power-limited fire-alarm circuits: Comply with UL 1424.

E. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

F. Ground Conductor: Insulated.

G. Conductor Insulation:
   1. Type TFN/THHN/THWN-2: Comply with UL 83.
   2. Type XHHW-2: Comply with UL 44.

H. Armor: Steel, interlocked.

I. Jacket: PVC applied over armor.

2.04 ARMORED CABLE, TYPE AC

A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in an overall metallic sheath.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems; a part of Atkore International.
   2. Alpha Wire Company.
   3. American Bare Conductor.
   4. Belden Inc.
   5. Cerro Wire LLC.
   6. General Cable Technologies Corporation.
   7. Okonite Company.
   8. Southwire Company.
   9. WESCO.

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. RoHS compliant.
   3. Comply with UL 4.
   4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide".

D. Circuits:
   1. Single circuit and multicircuit with color-coded conductors.
   2. Power-limited fire-alarm circuits: Comply with UL 1424.

E. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

F. Ground Conductor: insulated.

G. Conductor Insulation: Type THHN/THWN-2. Comply with UL 83.

H. Armor: Steel, interlocked

2.05 FIRE-ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Wire & Cable Inc.
   2. CommScope Inc.
   3. Comtran Corporation.
   4. Draka Cableteq USA; a Prysmian Group company.
   5. Genesis Cable Products; Honeywell International, Inc.
   6. Radix Wire.
   7. Rockbestos-Suprenant Cable Corp.
   8. Superior Essex Inc.
   9. West Penn Wire.
   10. Windy City Wire.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, pair not less than No. 16 AWG or size as recommended by system manufacturer.
   1. Circuit Integrity Cable: Twisted pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
   1. Low-voltage Circuits: No. 16 AWG, minimum, in pathway.
   2. Line-voltage Circuits: No. 12 AWG, minimum, in pathway.
   3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.06 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Basis-of-Design Product: Subject to compliance requirements, provide Service Wire Co. or a comparable product by one of the following:
   1. 3M Electrical Products.
   2. AFC Cable Systems; a part of Atkore International.
   3. Gardner Bender.
   4. Hubbell Power Systems, Inc.
   5. Ideal Industries, Inc.
   6. ILSCO.
   7. NSi Industries LLC.
   8. O-Z/Gedney; a brand of Emerson Industrial Automation.
   9. TE Connectivity Ltd.
   10. Thomas & Betts Corporation; A Member of the ABB Group.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set

screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
   1. Material: Copper.
   2. Type: One hole with standard barrels.
   3. Termination: Compression.

PART 3 EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper solid for No. 16 AWG and smaller, stranded for No. 14 AWG and larger.

B. Feeders: Copper for feeders smaller than No. 4 AWG; copper for feeders No. 4 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

D. VFC Output Circuits Cable: Flexible stranded for all sizes.

E. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

F. PV Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2 single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.

F. Feeders in Cable Tray: Type THHN/THWN-2, single conductors in raceway.

G. Exposed Branch Circuits, including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

H. Branch Circuits concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

I. Branch Circuits concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

J. Branch Circuits installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.

K. Branch Circuits in Cable Tray: Type THHN/THWN-2, single conductors in raceway.

L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.

M. VFC Output Circuits: Type XHHW-2 in metal conduit.

N. PV Circuits: Type PV for PV source circuits rated at 2000 V.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

A. National Electrical Installation Standards (NEIS), published by the National Electrical Contractors' Association (NECA) shall be used as a reference to establish a standard for quality of installation workmanship.

B. Make conductor lengths for parallel circuits equal by actual length comparison before installing in conduit.

C. Smallest wire sizes allowed are #12 AWG for lighting and power and #14 AWG for controls.

D. Provide dedicated neutrals for branch circuits. Shared neutrals will not be allowed.

E. Control conductors shall be routed in separate raceways from power conductors.

F. Provide separate raceways for 480/277V feeders/branch circuits and 208/120V feeders/branch circuits.

G. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

H. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 “Raceways and Boxes for Electrical Systems” prior to pulling conductors and cables.

I. 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.

J. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

K. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

L. Support cables according to Section 26 05 29 “Hangers and Supports for Electrical Systems”.

3.04 INSTALLATION OF FIRE-ALARM WIRING

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal pathway according to Section 26 05 28 “Hangers and Supports for Communication Systems”.

1. Install plenum cable in environmental airspaces, including plenum ceilings.
2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system shall be installed in a dedicated pathway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI is not permitted.
3. Signaling Line Circuits: Power-limited fire-alarm cables may be installed in the same cable or pathway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system’s wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in

close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire-alarm control panel and the remote transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.05 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written requirements. Provide documentation of the torque connections to engineer for closeout documentation. If values do not match manufacturer recommendation, contractor to provide additional torqueing and provide documentation that the requirements have been adhered to. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6-inches of slack.

D. Comply with requirements in Section 28 31 00 "Fire Detection and Alarm" for connecting, terminating, and identifying wires and cables.

3.06 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems".

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.07 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve-seals at penetrations of exterior floor and wall assemblies.

3.08 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.09 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements and test conductors feeding any critical equipment as deemed critical by the Owner's Representative.
    a. Megger testing for one half minute is required for all 600-Volt insulated wire #2 AWG and larger using a 500-Volt Megger for 208-Volt systems and a 1000-Volt Megger for 480-Volt systems.
    b. Test continuity between conductors and from each conductor to ground before initial energization of all service equipment, switchgear, switchboards, MCCs (including motors) and panelboards. Record test information for all cables tested on attached report.
    c. Using a Volt/Ohm meter, test all power conductors below #2 AWG for continuity to ground.

d. Test circuits for motor rotation, phaser to phaser sequence.

2. Perform each of the following visual and mechanical inspection and electrical tests in addition to tests stated in NETA Acceptance Testing Specification. Certify compliance with test parameters:
   a. Inspect exposed sections of conductors and cables for physical damage and correct connections according to the single-line diagram.
   b. Test bolted connections for high resistance using one of the following:
      1) A low-resistance ohmmeter.
      2) Calibrated torque wrench.
      3) Thermographic survey.
   c. Inspect compression-applied connectors for correct cable match and identification.
   d. Inspect for correct identification.
   e. Inspect cable jacket and condition.
   f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
   g. Continuity test on each conductor and cable.
   h. Uniform resistance of parallel conductors.
3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to a portable scanner. Correct deficiencies determined during scan.
   a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record of device.
   b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.
4. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

D. Cables will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports to record the following:
   1. Procedures used.
   2. Results that comply with requirements.
   3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 GENERAL

A. Conform to General Conditions, Supplementary Conditions, Division 01, Division 26, Division 27, and Division 28.

B. Review the Specifications and Drawings for coordination with additional requirements and information that applies to work under this Specification.

1.02 SUMMARY

A. Provide a complete grounding system that complies with the current edition of the National Electrical Code (NEC), and all applicable regulatory codes.

B. Provide all components necessary to complete the grounding system(s) consisting of:

1. Metal underground water pipes.
2. Metal frame of buildings.
3. Rod electrodes.
4. Building ground rings.
5. Ground bars.
6. Additional grounding and bonding components required.
7. Ground rod access (test) wells.

C. Performance Requirements: Maximum 5-ohms grounding system resistance.

1.03 REFERENCES

A. NFPA 70 – National Electrical Code (NEC); National Fire Protection Association; Most recent edition adopted by the Authority Having Jurisdiction, including all applicable amendments and supplements.

1.04 SUBMITTALS

A. Product Data: Provide manufacturers catalog cuts for grounding electrodes, conductors, and connections.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience with service facilities within 100 miles of the Project.

D. Testing Agency Qualifications: Certified by NETA or a NRTL.

E. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

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

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.02 MANUFACTURERS

A. Cooper Power Systems.
B. Storm Copper Components Co.
C. Harger.
D. Or other reviewed and approved Manufacturers.

2.03 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4” diameter by 10’-0” long.
B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
   1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches long.
   2. Backfill Material: Electrode manufacturer’s recommended material.
C. Ground Plates: 1/4” thick, hot-dip galvanized.

2.04 GROUND ROD TEST WELLS

A. Minimum size: 12” diameter by 24” long, schedule 40 PVC with belled hub.
B. Cover type: Flat steel with identification nameplate “GROUND TEST WELL”.

2.05 GROUND BARS

A. Predrilled rectangular bars of annealed copper, 1/4" thick by 4” high in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.
   1. Provide 12” long grounding bus bars in small electrical rooms, telecom (IDF) rooms, and closets.
   2. Provide minimum 20” long grounding bus bars in large electrical rooms and telecom (MDF) rooms.
B. Suitable for indoor and outdoor installations.

2.06 GROUND CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated with green colored insulation for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.

2.07 GROUND ELECTRODE CONNECTORS

A. Connectors for grounding electrode conductor to ground rod shall be of thermal fusion type; conductor-to-conductor connections may be either thermal fusion or approved hydraulically applied compression type.

2.08 GROUNDING BUSHINGS

A. Grounding bushings shall be matched to the ampacity of the grounding conductor and shall have approved set-screw type grounding lug connectors.

2.09 GROUNDING CONNECTORS

A. Shall meet the requirements of ground bushings, cast, set-screw, or bolted type.
B. Clamps shall be matched to the ampacity of the grounding conductor. Provide approved raceway hub where grounding conductor is shown protected by conduit or armored cable. Clamps shall be U-bolt type for connection to water pipes.

PART 3 EXECUTION

3.01 APPLICATION

A. Grounding conductors shall be soft drawn, bare, stranded copper unless otherwise noted. Size as shown on the plans and per NEC, Article 250.

1. Grounding Electrode Conductors for AC Systems:
    a. See NEC Table 250.66.
2. Equipment Grounding Conductors:
    a. See NEC Table 250.122.
    b. Equipment grounding conductors may be insulated; provide green insulation and/or approved permanent identification for conductors larger than #6 AWG.

B. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.02 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.03 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

B. Transformer: Ground transformer secondary to building steel.

3.04 INSTALLATION

A. Provide system and equipment grounding in accordance with the applicable codes and ordinances and as indicated on the Plans.

B. Ground service equipment, separately derived systems, conduits, devices, and equipment in accordance with NEC, Article 250.

C. Equipment Grounding:

1. Install insulated equipment grounding conductors with all feeders and branch circuits including but not limited to the ground bus in all switchgear, switchboards, motor control centers, transformers, panelboards and load centers to all electrical equipment and devices.
2. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters,

dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

3. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
4. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
5. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
6. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
7. Metallic Fences: Comply with requirements of IEEE C2.
    a. Grounding Conductor: Bare, tinned copper, not less than No. 2 AWG.
    b. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
    c. Barbed Wire: Strands shall be bonded to the grounding conductor.

D. Inspection: Place no backfill around made electrode earth grounding systems until the installation is inspected and approved by the Owner’s Representative and Electrical Inspector.

E. Bonding: Conduit systems shall be effectively grounded and bonded together by approved bonding means in accordance with the NEC. Verify ground continuity between conduits, boxes, receptacles, and equipment.

1. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
    a. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
    b. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
    c. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
2. Grounding and Bonding for Piping:
    a. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
    b. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
    c. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

3. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
4. Terminate metallic raceways at metal housings, not having a solid mechanical and electrical connection to housing, with a ground bushing. Provide flexible grounding strap mounted to raceway exterior where raceway crosses a seismic joint.

F. Install ground electrodes at locations indicated on Plans or required by NEC.
1. Unless otherwise indicated, top of electrode shall be 6” below finished surface.
2. Bury electrode conductors below finished surface.

G. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing. Bond steel together.

H. Provide bonding to meet requirements described in Section 1 of this Specification.

3.05 GROUND CONTINUITY

A. Maintain ground continuity throughout the entire electrical system.

B. Permanently connect the electrical system neutral to the water service. The system shall be grounded only at transformer secondaries and at the main switchboard. Branch panel neutrals must be isolated from additional points of grounding.

C. Provide approved grounding bushings or locknuts on all conduits terminating in panelboards, pullboxes, or other enclosures to insure continuity of conduit grounding connections.

D. Securely ground lighting fixtures via the conduit system or by a separate suitable grounding conductor where flexible conduit is used.

E. Provide a separate grounding conductor in all non-metallic conduits and in all flexible metallic conduit runs. Connect to the grounding system in an approved manner.

F. Cable trays used as equipment grounding conductors shall be specifically approved for that purpose. Special bolted mechanical connectors and/or bonding jumpers shall be utilized to ensure system ground continuity.

G. All plug-in receptacles shall be bonded to the box and raceway ground system unless specific isolated ground connections are shown on the Drawings.

3.06 FENCE GROUNDING

A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:
1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
a. Gates and Other Fence Openings: Ground fence on each side of opening.
1) Bond metal gates to gate posts.
2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use minimum No. #2/0 AWG wire and bury it at least 24 inches below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. #2 AWG conductor. Connect conductor to each fence component at grounding location.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.07 GROUND CONNECTIONS

A. All grounding connections shall be carefully made to insure low system impedance. Locate grounding connections to allow future servicing and expansion.

B. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Use exothermic welds for underground, exterior and embedded connections. Use compression connections in interior locations where connections available for visual inspection. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.08 PROTECTION

A. Ground conductors shall be protected from mechanical injury during construction. Provide protective coverings or rigid non-ferrous conduit.

3.09 GROUND RODS

A. Ground rods shall be driven into undisturbed soil to full depth. Provide additional rods, ionic salt solutions and the like where special low-resistant grounds are specified.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. Use exothermic welds for all below-grade connections.
3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

3.10 TEST WELLS

A. Ground rod driven through drilled hole in bottom of handhole.

1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

3.11 THROUGH-SLAB GROUND PENETRATIONS

A. Ground conductors extending through the slab shall be protected by a rigid conduit sleeve; the void portion of the sleeve shall be packed with a non-hardening type duct seal.

3.12 HIGH VOLTAGE CABLE GROUNDS

A. Metallic shielding components, such as tapes, wires or braids, and their associated conducting or semi-conducting components shall be grounded per NEC Article 250. Ground terminations shall be made according to the manufacturer’s written specifications.

3.13 TESTING

A. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

B. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

C. Measure the Ohmic value of the electrical service entrance metallic “Electrical System Ground” with reference to “Earth Ground” using the “Multiple Ground Rods” method and suitable instruments. Maximum resistance to ground shall be less than 5 ohms. If this resistance cannot be obtained, notify the Owner’s Representative in writing.

D. Provide a paper copy of the test results and in the record O&M Manuals.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 GENERAL

A. Conform to General Conditions, Supplementary Conditions, Division 01, and Division 26.

B. Review the Specifications and Drawings for coordination with additional requirements and information that apply to work under this Specification.

1.02 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Aluminum slotted support systems.
3. Nonmetallic slotted support systems.
4. Conduit and cable support devices.
5. Support for conductors in vertical conduit.
6. Structural steel for fabricated supports and restraints.
7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
8. Fabricated metal equipment support assemblies.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
    a. Slotted support systems, hardware, and accessories.
    b. Clamps.
    c. Hangers.
    d. Sockets.
    e. Eye nuts.
    f. Fasteners.
    g. Anchors.
    h. Saddles.
    i. Brackets.
2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For each seismic-restraint device not defined by details and charts on the drawings.
   1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   2. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic and wind forces required to select seismic and wind restraints and for designing vibration isolation bases.
      a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
   3. Include design calculations for seismic and wind restraints.
      a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
      b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
      c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
      d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.04 INFORMATION SUBMITTALS

A. Coordination Drawings. Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
   2. Ductwork, piping, fittings, and supports.
   3. Structural members to which hangers and supports will be attached.
   4. Size and location of initial access modules for acoustical tile.
   5. Items penetrating finished ceiling, including the following:
      a. Luminaires.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
      f. Projectors.

B. Seismic Qualification Data: Certificates, for hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

D. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless applicable city, county, and state codes and ordinance requirements are more stringent.

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD in addition to preapproval, showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing shall be provided.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.

1.06 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design hanger and support system.

B. Seismic Performance for Electrical Component Supports located within structures falling under seismic design categories C, D, E, and F: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term “withstand” means “the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the supported equipment and systems will be fully operational after the seismic event”.
2. All equipment shall be seismically rated for the applicable conditions.
3. Component Importance Factor: 1.5.

C. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame Rating: Class 1.
2. Self-extinguishing according to ASTM D 635.

2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch diameter holes at maximum of 8 inches o.c. in at least one surface.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Gripple, Inc., pipe support and hanging systems, or comparable products by one of the following:
   a. Allied Tube & Conduit; a part of Atkore International.
   b. B-line, an Eaton business.

c. ERICO International Corporation.
d. Flex-Strut Inc.
e. GS Metals Corp.
f. G-Strut.
g. Haydon Corporation.
h. Metal Ties Innovation.
i. Thomas & Betts Corporation; A Member of the ABB Group.
j. Unistrut; Part of Atkore International
k. Wesanco, Inc.

2. Pipe Bracket Kit Description: Pipe Bracket (PB1FT / PB2FT / PB3FT / PB4FT) and Universal (GC2-T) clamps or Compact (GC2-C) clamps. Manually assembled in the field to support multiple parallel pipes.
3. Approvals: ISO 17025, MSS-SP 58, IAPMO/ANSI UPC 1-2012, UL 2239, and UL 2043.
4. Material for Channel: Pregalvanized steel G90 (Z275).
5. Channel Width: Selected for applicable load criteria. Default is 1-3/4 inches.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cooper Industries, Inc.
   b. Flex-Strut Inc.
   c. Haydon Corporation
   d. MKT Metal Manufacturing
   e. Thomas & Betts Corporation; A Member of the ABB Group.
   f. Unistrut; Part of Atkore International.
2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Channel Material: 6063-T5 aluminum alloy.
4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
5. Channel Width: selected for applicable load criteria. Defaults are: 1-5/8 inches or 1-1/4 inches.
6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch diameter holes at a maximum of 8 inches o.c., in at least one surface.

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

a. Allied Tube & Conduit; a part of Atkore International.
b. B-line, an Eaton Business.
c. Fabco Plastics Wholesale Limited.
d. G-Strut.
e. Haydon Corporation.
f. Seasafe, Inc.; AMICO, a Gibraltar Industries Company.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Channel Width: Selected for applicable load criteria. Defaults are: 1-5/8 inches or 1-1/4 inches.
4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
5. Fitting and Accessory Materials: Same as those for the channels and angles, except metal items may be stainless steel.
6. Rated Strength: Selected to suit applicable load criteria.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Conduit and Cable Support Devices: Steel and malleable iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Gripple, Inc.; adjustable clamp and pipe bracket system for suspension of conduits 4-inch and smaller, or comparable products by one of the following:
   a. Allied Tube & Conduit; a part of Atkore International.
   b. B-line, an Eaton Business.
   c. Fabco Plastics Wholesale Limited.
   d. G-Strut.
   e. Haydon Corporation.
   f. Seasafe, Inc.; AMICO, a Gibraltar Industries Company.
2. Wire Rope Type 1: High tensile steel wire rope, to ASTM A1023/1023M, class A zinc coating; 7 by 7 and 7 by 19 cross-sectional construction; having a tensile strength of 256,000 psi; lengths, diameters, and wire construction as indicated on Shop Drawings. Cables are pre-cut lengths with fused ends. Pre-made end attachments are available depending on the application.
3. Wire Rope Type 2: High tensile steel wire rope, to ASTM A492, Type 316 stainless steel, 7 by 7 cross-sectional construction; having a tensile strength of 256,000 psi; lengths, diameters, and wire construction as indicated on Shop Drawings. Cables are pre-cut lengths with fused ends. Pre-made end attachments are available depending on the application.
4. Y-Fit: Two wire ropes, arranged to form two leg attachment points at one end with a ferrule. Factory-crimped with a 30-ton hydraulic press. For loads up to 200 lbs (5:1 safety factor).
5. Adjustable Fastener Type 1: One-piece die cast type ZA2 zinc two-channel housing; encasing a series of Type 302 stainless-steel springs with serrated self-locking steel wedges, adjustable with setting key or integrated mechanism; UV stabilized homopolymer polypropylene end caps. Sizes as indicated on Shop Drawings. Safe working load (SWL) with 5:1 safety factor. Gripple model HF/XP Adjustable Fastener.
6. Adjustable Fastener Type 2: One-piece Type 316 stainless-steel two channel housing to ASTM A167; encasing a series of Type 302 stainless-steel springs with serrated self-locking ceramic wedges, adjustable with setting key; Type 316 A4 stainless-steel end caps. For load

of 200 lb or 500 lb. SWL with 5:1 safety factor. Model: Gripple No. 3 or 4 Stainless Steel Adjustable Fastener.

7. Adjustable Fastener Type 3: One-piece die cast type ZA2 zinc one-channel housing; encasing a series of Type 302 stainless-steel springs with serrated self-locking ceramic wedge adjustable with setting key; Type 316 A4 stainless-steel end caps. For load of 200 lb or 500 lb. SWL with 5:1 safety factor. Model: Gripple No. 3 or 4 Stainless Steel Adjustable Fastener.
8. Adjustable Fastener Type 4: One-piece die cast type ZA2 zinc one-channel housing; encasing a series of Type 302 stainless-steel springs with serrated self-locking steel wedge, adjustable with integrated mechanism; UV stabilized homopolymer polypropylene end caps. Sizes as indicated on Shop Drawings. SWL with 5:1 safety factor. Gripple model STZ2/TZ3 Adjustable Fastener.
9. Adjustable Fastener Type 5: Mild steel (type EN1A), bright zinc plated, one-channel body; encasing a series of Type 302 stainless-steel springs with serrated self-locking grade 40 chrome steel balls, adjustable by means of an integrated mechanism, capable of accommodating load of 100 lb, 200 lb, or 500 lb as required. Model No. 2, 3, or 4 Trapeze Plus Adjustable Fastener.
10. Adjustable Fastener Type 6: One-piece die cast type ZA2 zinc two-channel housing; encasing a series of Type 302 stainless-steel springs with serrated self-locking ceramic rollers, adjustable with setting key and extra allen key locking mechanism; UV stabilized homopolymer polypropylene end caps. UL/CSA listed. Manufactured in an ISO 9002 facility. Sizes as indicated on Shop Drawings. SWL with 5:1 safety factor. Gripple Lockable Plus Adjustable Fastener.
11. Adjustable Fastener Type 7: Bright nickel-plated, type ZA2 zinc housing; encasing a Delrin 511P NC010 spring with self-locking brass roller, adjustable with integrated mechanism. For loads up to 30 lb. SWL with 5:1 safety factor. Model: Gripple Angle Hanger Family
12. End Fixing Type 1: Mechanically-spliced wire rope with factory end fixing using a 30-ton hydraulic press; to accommodate the design load and safety factor of the fastener kit (loop, stud, toggle, hook, 90-degree eyelet, or shot fire).
13. End Fixing Type 2 (C-Clip): Zinc ZA2 for load of 100 lb (Gripple No. 2). C-Clip: 1/8 inch or ¼ inch with crimped loop fastener. Mechanically-spliced wire rope with factory end fixing using a 30-ton hydraulic press; to accommodate the design load and safety factor of the fastener kit.
14. End Fixing Type 2 (Shot Fire Ceiling Clip and Pin): Galvanized steel pin and clip for load of 25 lb (Gripple No. 1) or 100 lb (Gripple No. 2). Shot Fire: C925 with crimped loop fastener. Mechanically-spliced wire rope with factory end fixing using a 30-ton hydraulic press; to accommodate the design load and safety factor of the fastener kit.
15. End Fixing Type 3 (Eyelag): Galvanized steel eyelag screw for load of 25 lb (Gripple No. 1) or 100 lb (Gripple No. 2). Eyelag: ELD with crimpled loop fastener. Mechanically-spliced wire rope with factory end fixing using a 30-ton hydraulic press; to accommodate the design load and safety factor of the fastener kit.
16. End Fixing Type 4 (Swivel Toggle): Zinc-plated steel, 1-1/2 inches, for load of 100 lb (Gripple No. 2) or 200 lb (Gripple No. 3). Swivel Toggle: Gripple Spider/MDI. Mechanically-spliced wire rope with factory end fixing using a 30-ton hydraulic press; to accommodate the design load and safety factor of the fastener kit.
17. End Fixing Type 5 (Loop Ferrule): Type 316 stainless-steel, ASTM A167, 1/2 inch by 5/16 inch, for load of 100 lb (Gripple No. 2) or 200 lb (Gripple No. 3). Mechanically-spliced wire rope with factory end fixing using a 30-ton hydraulic press; to accommodate the design load and safety factor of the fastener kit.
18. End Fixing Type 6 (Toggle Plate and Endstop): Type 304/A2 stainless-steel, 1/4 inch thickness, 5/16 inch by 1-9/16 inch, for load of 100 lb (Gripple No. 2). Mechanically-spliced

wire rope with factory end fixing using a 30-ton hydraulic press; to accommodate the design load and safety factor of the fastener kit.

19. End Fixing Type 7 (Threaded Stud): Type 304/A2 stainless-steel, 1/4 – 20 (M6 x 1) threaded rod, for load of 100 lb (Gripple No. 2) or 200 lb (Gripple No. 3). Mechanically-spliced wire rope with factory end fixing using a 30-ton hydraulic press; to accommodate the design load and safety factor of the fastener kit.
20. End Fixing Type 8 (Hook Stud): Type 304/A2 stainless-steel, 1/4 inch thickness, 5/8 inch by 3 inches, for load of 100 lb (Gripple No. 2). Mechanically-spliced wire rope with factory end fixing using a 30-ton hydraulic press; to accommodate the design load and safety factor of the fastener kit.
21. End Fixing Type 9 (Barrel): Zinc-plated steel with aesthetic fixing for use with up to 1/4 inch or 3/8 inch threaded anchor, for load of 200 lb. SWL with 5:1 safety factor.

E. Accessories:

1. Cable Basket Adaptor: Galvanized steel adaptor for load of 100 lb (Gripple No. 2), to suspend cable basket with wire diameter up to 1/4 inch.
2. Y-Fit: Two wire ropes, arranged to form two leg attachment points at one end with a ferrule. Factory-crimped with a 30-ton hydraulic press. For loads of 50 lb (Gripple No. 1), 100 lb (Gripple No. 2) or 200 lb (Gripple No. 3).
3. Karabiner: Galvanized steel karabiner for load of 200 lb with 5:1 safety factor, to suspend cable basket.
4. G-Bracket: Cold formed mild steel bracket (BS EN 10346:2009 DX51D) with slots to support cable trays, for load up to 100 lb (SWL with 3:1 safety rating), compatible with Y-fit range.
5. GF Bracket: Ductile iron with hot dip galvanized finish. Bracket for clamping onto wide flange beam section, suitable for 1/4 inch to 1/2 inch flange thickness, and for use with 1/2 inch diameter threaded rod supplied by others.

F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedge plug or plugs for nonarmored 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 made of malleable iron.

G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

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.
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        1) Hilti, Inc.
        2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.
        4) Simpson Strong-Tie Co., Inc.
2. Mechanical-Expansion Anchors: Insert wedge type, zinc-coated or stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) B-line, an Eaton business.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti, Inc.
4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All stainless-steel springhead type.
7. Hanger Rods: Threaded steel.

2.03 SEISMIC RESTRAINT ACCESSORIES

A. Manufacturers: Provide products by same manufacturer as channels and designed for use with that product.
   1. Materials for Fittings and Accessories: ASTM A575, ASTM A576 or ASTM A36.
B. Hanger-Rod Stiffener: Slotted steel channels with internally bolted connections to hanger rod.
C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for seismically rated equipment mountings and matched to type and size of anchor bolts and studs.
E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings and matched to type and size of attachment devices used.
F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

PART 3 EXECUTION

3.01 GENERAL

A. Coordinate layout and installation of seismic bracing with building structural system and architectural features, and with mechanical, fire-protection, electrical, and other building features in the vicinity.
B. Coordinate concrete bases with building structural system.

3.02 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
   1. NECA 1.

2. NECA 101.
3. NECA 102.
4. NECA 105.
5. NECA 111.

B. Provide firestopping materials and installations for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 26 05 33 “Raceways and Boxes for Electrical Systems”.

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25-percent in the future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps using spring friction action for retention in support channel.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.04 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Section.

B. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified by applicable engineer of record.

C. Raceways shall not be supported from ducts, pipes or other systems foreign to the electrical installation. The entire electrical installation shall be kept independent from any other trade.

D. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, according to NFPA 70.

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

F. Install seismic restraints according to applicable codes and regulations and as approved by authority having jurisdiction, unless more stringent requirements are indicated.

1. Use bolted connections with steel brackets, slotted channel and slotted channel fittings to transmit the design loads.

G. Seismic Bracing Installation:

1. Expansion and Contraction: Install to allow for thermal movement of braced components.
2. Cable Braces: Install snug tight unless otherwise recommended by the manufacturer. Do not exceed the maximum cable slack as recommended by the cable manufacturer.
3. Attachment to Structure: If specific attachment is not indicated, anchor bracing to the structure at flanges of beams and columns, upper truss chords of bar joints, or at concrete members.

H. Equipment and Hanger Restraints:

1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

I. Install cables so they do not bend across edges of adjacent equipment or building structure.

J. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
    a. Holes for Expansion Anchors in Concrete: Drill at locations and to depths that avoid reinforcing bars.
5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or spring-tension clamps.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

K. Drilled-in Anchors

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

L. Electrical Equipment Anchorage

1. Floor Mounted Equipment Anchoring: All floor-mounted equipment shall be secured to housekeeping bases with ductile steel anchor bolts, preset in the concrete base as leveled by self-leveling laser leveling tool. Secure vibration mounts, where required, to the concrete bases such that the equipment is free to vibrate but cannot move from the base.
    a. Housekeeping Bases:
        1) Provide appropriately sized concrete housekeeping bases for all floor mounted equipment unless otherwise noted. Size concrete bases so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base. Bases shall be 3-1/2” nominal thick concrete with #4 reinforcing bars each way on 12 inch centers

and doweled to floor slab unless noted otherwise. Trowel finish with 1” beveled edge all around and self-leveling grout no less than 3000 psi strength, 28-day compressive-strength concrete. Slab shall be level to an overall tenth of a two percent slope or less. Flatness shall have a 0.03 inch tolerance as demonstrated by laser level. Provide steel angle iron on edges of housekeeping bases.

b. Equipment anchors to concrete base:
   1) Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2) Install anchor bolts to elevations required for proper attachment to supported equipment.
   3) Install anchor bolts according to anchor-bolt manufacturer's written instructions.
c. Bushings for Floor Mounted Equipment Anchors:
   1) Install to allow for resilient media between anchor bolt or stud and mounting hole in concrete.

2. Wall Mounted Equipment Fastening: Rigidly secure all flush or surface mounted equipment, such as panelboards or cabinets to structure. Use expanding type anchors for concrete or masonry construction.
   a. Anchor Bolt Bushing Assemblies for Wall Mounted Equipment: Install to allow for resilient media where equipment or equipment mounting channels are attached to wall.
3. Torque bolts and nuts on studs to values recommended by equipment manufacturer.
   a. Mark lugs after torquing with red paint such that paint will be visibly disturbed if lugs are disturbed.

3.05 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS D1.1/D1.1M.

3.06 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

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

END OF SECTION

SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 GENERAL

A. Conform to General Conditions, Supplementary Conditions, Division 01, Division 27, and Division 26.

B. Review the Specifications and Drawings for coordination with additional requirements and information that apply to work under this Specification.

1.02 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Floor boxes.
7. Boxes, enclosures, and cabinets.
8. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 27 05 28 “Pathways for Communications Systems” for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.03 DEFINTIONS

A. ARC: Aluminum rigid conduit.

B. EMT: Electrical metallic tubing.

C. GRC: Galvanized rigid steel conduit.

D. IMC: Intermediate metal conduit.

1.04 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

C. Samples: For wireways, nonmetallic wireways and surface raceways and for each color and texture specified, provide 12-inch long sample(s).

1.05 INFORMATION SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting

provisions, including those for internal components, from manufacturer.

1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

D. Source quality-control reports.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 METAL CONDUITS, TUBING, AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. Anamet Electrical, Inc.
4. Electri-Flex Company.
5. FSR Inc.
6. O-Z/Gedney; and EGS Electrical Group brand.
7. Patriot Aluminum Products, LLC.
8. Picoma Industries.
9. Republic Conduit.
10. Robroy Industries.
11. Southwire Company.
12. Thomas & Betts Corporation, A Member of the ABB Group.
13. Western Tube and Conduit Corporation.
14. Wheatland Tube Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. FMC: Comply with UL 1; zinc-coated steel.

I. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

J. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Conduit fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
   2. Fittings for EMT:
      a. Material: Steel.
      b. Type: Compression.
   3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
   4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

K. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Anamet Electrical, Inc.
   3. Arnco Corporation.
   4. CANTEX INC.
   5. CertainTeed Corporation.
   6. Condux International Inc.
   7. Electri-Flex Company.
   8. Kraloy.
   9. Lamson & Sessions.
   10. Niedax Inc.
   11. RACO; Hubbell.
   12. Thomas & Betts Corporation, A Member of the ABB Group.

B. Listing and labeling: Nonmetallic conduits, tubings, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ENT: Comply with NEMA TC 13 and UL 1653.

D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. LFNC: Comply with UL 1660.

F. Rigid HDPE: Comply with UL 651A.

G. Continuous HDPE: Comply with UL 651B.

H. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.

I. RTRC: Comply with UL 1684A and NEMA TC 14.

J. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

K. Fittings for LFNC: Comply with UL 514B.

L. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

M. Solvent cements and adhesive primers shall comply with the testing and product requirements as

required for approval from the AHJ.

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.; a division of Cooper Industries.
   2. Hoffman; a brand of Pentair Equipment Protection.
   3. MonoSystems, Inc.
   4. Square D.
   5. Wiegmann; division of Hubbell Incorporated.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, unless otherwise indicated, and sized according to NFPA 70.
   1. Metal wireways installed outdoors shall be NEMA-3R and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged Type, unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.04 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Moulded Products, Inc.
   2. Hoffman; a brand of Pentair Equipment Protection.
   3. Lamson & Sessions.
   4. Niedax Inc.

B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

E. Fittings and Accessories: Coupling, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for a complete system.

F. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Solvent cements and adhesive primers shall comply with testing and product requirements as required per AHJ.

2.05 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Single piece galvanized steel complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell incorporated; HBL750 or comparable product by one of the following:
      a. MonoSystems, Inc.
      b. Panduit Corp.
      c. Wiremold/Legrand.

C. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell incorporated; HBL6750 or comparable product by one of the following:
      a. MonoSystems, Inc.
      b. Panduit Corp.
      c. Wiremold/Legrand.
   2. Wiring Channels: Dual, unless otherwise indicated. Multiple channels shall be used where circuit voltage and low voltage are in same raceway to maintain separation. Each channel shall be capable of housing a standard 20 to 30 amp NEMA device flush within the raceway.
   3. Surface steel metal raceways shall be available from the manufacturer as prewired and preassembled in order to provide the highest quality control and appearance.

D. Surface Aluminum Raceways: Anodized Aluminum with snap-on covers complying with UL 5. Manufacturer's standard anodized aluminum finish.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell incorporated; HBLALU5000 or a comparable product by one of the following:
      a. MonoSystems, Inc.
      b. Panduit Corp.
      c. Wiremold / Legrand.
   2. Wiring Channels: Dual. Each wiring channel shall be capable of housing a standard 20 to 30 amp NEMA device flush within the raceway. Multiple channels shall be used to provide division between circuit voltage and low voltage.
   3. Aluminum raceways shall be available as factory pre-wired and assembled in order to provide highest quality control and appearance.

E. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell incorporated; PB3 or a comparable product by one of the following:
      a. MonoSystems, Inc.
      b. Panduit Corp.
      c. Wiremold / Legrand.

F. Tele-Power Poles:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; HBLPP Series or a comparable product by one of the following:
      a. MonoSystems, Inc.
      b. Panduit Corp.

c. Wiremold / Legrand.

2. Material: Galvanized steel with ivory baked-enamel finish.
3. Height: 10 feet-2 inches, 12 feet-2inches or 15 feet-2 inches as required. Coordinate heights with Architectural Elevations for associated location.
4. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harness, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.06 BOXES, ENCLOSURES, AND CABINETS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; steel boxes or comparable product by one of the following:
   1. Adalet.
   2. Cooper Technologies Company.
   3. EGS/Appleton Electric.
   4. Erickson Electrical Equipment Company.
   5. FSR Inc.
   6. Hoffman; a brand of Pentair Equipment Protection.
   7. Kraloy.
   8. Milbank Manufacturing Co.
   9. MonoSystems, Inc.
   10. Oldcastle Enclosure Solutions.
   11. O-Z/Gedney; an EGS Electrical Group brand.
   12. RACO; Hubbell.
   13. Robroy Industries.
   14. Spring City Electrical Manufacturing Company.
   15. Stahlin Non-Metallic Enclosures.
   16. Thomas & Betts Corporation, A Member of the ABB Group.
   17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Metal Floor Boxes:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; B series or a comparable product by one of the following:
      a. FSR, Inc.
      b. Thomas & Betts Corporation, A Member of the ABB Group.
      c. Wiremold / Legrand.
   2. Material: Cast metal or sheet metal.
   3. Type: Fully adjustable.
   4. Shape: Rectangular.

5. Size: 3 gang.
6. Cover: Brushed Aluminum or Brass.
7. Listing and Labeling: Shall comply with UL 514C. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, rectangular.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; PFBRG3 rectangular floor box or a comparable product by one of the following:
   a. FSR, Inc.
   b. Thomas & Betts Corporation, A Member of the ABB Group.
   c. Wiremold / Legrand.
2. Cover Finishes: Brass or Aluminum for carpet or tile applications.
3. Listing and Labeling: Nonmetallic floor boxes shall be listed to comply with UL 514C and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Surface Activated Multi Service Concrete Floor Boxes: Capable of supplying Power, Data, Voice, and AV services.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; System One floor box, or a comparable product by one of the following:
   a. FSR, Inc.
   b. Thomas & Betts Corporation, A Member of the ABB Group.
   c. Wiremold / Legrand.
2. Material: S1CFB, cast iron, S1SFB, steel, S1SBAV, steel 1-1/2 inch hub, or S1PFB, non-metallic.
3. Cover Finishes: Black for carpet, tile or furniture feed applications.
4. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Recessed Activation Multi Service Metal Concrete Floor Boxes: Capable of supplying Power, Data, Voice, and AV services.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; System One CFB6 floor box, or a comparable product by one of the following:
   a. FSR, Inc.
   b. Thomas & Betts Corporation, A Member of the ABB Group.
   c. Wiremold / Legrand.
2. Floor Box Material: Cast Iron or Steel.
3. Gangs: 6 gang, unless indicated otherwise.
4. Cover Style: Standard carpet, standard tile, or standard finished concrete as required.
5. Minimum Depth: 2.5 inches, 3 inches, 3.25 inches or as required.
6. Cover Finishes:
   a. Rectangular Covers: Aluminum painted, brass painted, black painted, nickel painted or bronze painted. Coordinate with Architect.
   b. Round Covers: brass plated, aluminum plated, nickel plated, bronze plated or black painted. Coordinate with Architect.
7. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined by NFPA

70, by a qualified testing agency, and marked for intended location and application.

J. Recessed Activation Raised Access Floor and Wood Floor Boxes: Capable of supplying Power, Data, Voice, and AV services in a raised floor or wood floor application.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; System One AFB4 floor box, or a comparable product by one of the following:
      a. FSR, Inc.
      b. Thomas & Betts Corporation, A Member of the ABB Group.
      c. Wiremold / Legrand.
   2. Material: Steel.
   3. Cover Finishes: Powder coated aluminum, brass, black, gray, or ivory for carpet, tile, or furniture feed applications.
   4. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined by NFPA 70, by a qualified testing agency, and marked for intended location and application.

K. Convention Center Utility Boxes: Capable of supplying Power, Data, Voice and AV services.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; HBLSCCUB series convention center utility box or a comparable product by one of the following:
      a. Wiremold / Legrand.
   2. Box Material: Corrosion resistant painted steel 14 gauge G 90 HBLSCCUPDW or stainless steel 14 gauge 304 HBLSCCUPDWSS.
   3. Cover Ratings: Heavy-duty covers rated at 32,000 lbs with a 2 X safety factor. Rated to UL 514.
   4. Configuration: Supplied as power, data, and communications.
   5. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

L. Recessed Activation Ballroom Floor Box.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; Hubbell CFB8 high cover load rated concrete floor box, or a comparable product by one of the following:
      a. FSR, Inc.
      b. Thomas & Betts Corporation, A Member of the ABB Group.
      c. Wiremold / Legrand.
   2. Material: Steel.
   3. Gangs: Eight total gangs with one, two, three, and four gang plates to be configured by the Contractor.
   4. Conduit Knockouts: (4) 1.5 inches, 1.25 inches, and 1 inch concentric.
   5. Minimum Depth of Pour: 6.95 inches.
   6. Cover Finishes: Machined Aluminum.
   7. Cover Rating: 20,000 lb recommended loading with a 40,000 lb maximum rating.
   8. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

M. Residential Floor Boxes with Recessed Activation.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Incorporated; RF400 series for concrete floors and RF515 for wood floors, or a comparable

product by one of the following:

a. Thomas & Betts Corporation, A Member of the ABB Group.

b. Wiremold / Legrand.

2. Cover Finishes:

a. For RF400: Solid Brass.

b. For RF515: Solid Brass.

3. Multi Service Capabilities: RF400 and RF515 supplied with low voltage divider to allow power, voice, and data in each box.

4. All residential floor boxes to be supplied with tamper-resistant receptacles.

5. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

N. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing up to 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

O. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.

1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

P. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

Q. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized cast iron with gasketed cover.

R. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

S. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

T. Gangable boxes are allowed.

U. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous hinge cover with flush latch unless otherwise indicated. Enclosures outside or interior wet locations shall be NEMA Type 3R.

1. Metal Enclosures: Steel finished inside and out with manufacturer’s standard enamel.

2. Nonmetallic Enclosures: Plastic or fiberglass.

3. Interior Panels: Steel; all sides finished with manufacturer’s standard enamel.

V. Cabinets:

1. NEMA 250, Type 1 galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer’s standard enamel. Enclosures outside or interior wet locations shall be NEMA Type 3R.

2. Hinged door in front cover with flush latch and concealed hinge.

3. Key latch to match panelboards.

4. Metal barriers to separate wiring of different systems and voltage.

5. Accessory feet where required for freestanding equipment.

6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.07 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.

2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. NewBasis.
   d. Oldcastle Precast, Inc.
   e. Quazite: Hubbell Power Systems, Inc.
   f. Synertech Moulded Products.
2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molding lettering, “ELECTRIC” or “SYSTEMS”.
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 inches wide by 24 inches long and larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

C. Fiberglass handholes and boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete or fiberglass.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. NewBasis.
   d. Nordic Fiberglass, Inc.
   e. Oldcastle Precast, Inc.
   f. Quazite: Hubbell Power Systems, Inc.
   g. Synertech Moulded Products
2. Standard: Comply with SCTE 77.
3. Color of Frame and Cover: Green.
4. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
5. Cover: Weatherproof, secured by tamper-resistant locking devices and having a structural load rating consistent with enclosure and handhole location.
6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction 0.50.
7. Cover Legend: Molded lettering, “ELECTRIC” or “SYSTEMS”.
8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

9. Handholes 12 inches wide by 24 inches long and larger. Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.08 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied:
   1. Tests of materials shall be performed by an independent testing agency.
   2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 EXECUTION

3.01 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC.
   2. Concealed Conduit, Aboveground: EMT.
   3. Underground Conduit: RNC, Type EPC-40-PVC. Concrete encased under roadways and streets, or areas subject to vehicular traffic.
   4. Connection to vibrating equipment (Including transformers and hydraulic, pneumatic, electric solenoid, or motor-driven equipment): LFMC.
   5. Boxes and enclosures, aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed, not subject to physical damage: EMT.
   2. Exposed, not subject to severe physical damage: EMT.
   3. Exposed, and subject to severe physical damage: GRC. Raceway locations include the following:
      a. Loading docks.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical Rooms.
      d. Gymnasiums.
   4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   5. Connection to vibrating equipment (Including transformers and hydraulic, pneumatic, electric solenoid, or motor-driven equipment): FMC, except use LFMC in damp or wet locations.
   6. Damp or Wet Locations: GRC.
   7. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA Type 4 stainless steel in institutional and commercial kitchens and dam or wet locations.

C. Minimum Raceway Size: 3/4 inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and

number of coats recommended by manufacturer.

3. EMT: Use compression fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.02 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this Section are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 260529 “Hangers and Supports for Electrical Systems” for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slabs.

F. Install no more than the equivalent of four (4) 90-degree bends in any conduit run except for control wiring circuits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches of enclosures to which attached.

I. Raceways embedded in slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to GRC before rising above floor.

J. Stub-ups to Above Recessed Ceilings.

1. Use EMT for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer’s written instructions.

L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to

protect conductors including conductors smaller than No. 4 AWG.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4 inch trade size and insulated throat metal bushings on 1-1/2 inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12-inches of slack at each end of pull wire. Cap underground raceways as designated as spare above grade alongside raceways in use.

S. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer’s written instructions. Tape and glue are not acceptable support methods.

T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

V. Comply with manufacturer’s written instructions for solvent welding RNC and fittings.

W. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25-feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100-feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    d. Attics: 135 deg F temperature change.
3. Install fittings that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fittings that

provide expansion and contraction for at least 0.000078 inch per foot of length and straight run per deg F of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for equipment, including light fixtures, subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

BB. Locate boxes so that cover or plate will not span different building finishes.

CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

EE. Set metal floor boxes level and flush with finished floor surface.

FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.03 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter
2. Install backfill as specified in Section 312000 "Earth Moving".
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving".
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.

b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Underground Warning Tape: Comply with requirements in Section 260553 “Identification for Electrical Systems”.

3.04 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2 inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer’s written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.06 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 “Penetration Firestopping”.

3.07 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 GENERAL

A. Conform to General Conditions, Supplementary Conditions, Division 01, and Division 26.

B. Review the Specifications and Drawings for coordination with additional requirements and information that apply to work under this Specification.

1.02 SUMMARY

A. Provide completely identified electrical systems and equipment that complies with the current edition of the National Electrical Code (NEC), and all applicable regulatory codes.

1.03 CALCULATIONS AND LABELLING

A. Provide complete Arc-Flash Hazards Calculation Report and label all equipment required per NFPA 70E to properly identify arc-flash hazards. Contractor is required to pay for and submit Arc-Flash Hazards Calculation to Owner's Representative and Engineer for review and approval prior to commencing work.

B. Provide complete Overcurrent Protective Device Coordination Study Report and install all devices per settings contained in Coordination Study Report. Contractor is required to pay for and submit Coordination Study Report to Owner's Representative and Engineer for review and approval prior to commencing work.

1.04 LABELLING GENERAL

A. Label each and every circuit breaker in the Main Switchboard(s) or Distribution Board(s) with a phenolic nameplate that identifies the load and location served.

B. Label all panelboards with a phenolic nameplate that also identifies the voltage, ampere rating, and source panel.

C. Provide a sign on the cover of each panelboard requiring a minimum of 36" or 42" of clear working space in front of the panel.

D. Label all transformers with a phenolic nameplate that identifies the source panel and the panel or load being served.

E. Label all disconnect switches and motor starters and permanently mounted electrical loads and control equipment with a phenolic nameplate that identifies the source panel, circuit number, and the load served.

1.05 REFERENCES

A. ANSI/NFPA 70 – National Electrical Code.

B. NFPA 70E – Standard for Electrical Safety in the Workplace.

C. ASTM International.

1.06 GENERAL REQUIREMENTS

A. Electrical and Communications Vaults shall be properly labeled per ID shown on the Drawings.

B. Underground conduits shall be properly labeled in vaults and in buildings where conduits stub up from below grade. Contractor shall be responsible for the ID names/numbers.

C. Electrical and Low-Voltage Equipment shall have placards with appropriate ID on front covers of equipment.

D. All interior conduit and junction boxes shall be labelled with panel name and circuit numbers of conductors routed via conduit and junction boxes.

E. Conductors shall be properly identified with both color coding and self-adhesive labels.

F. All equipment per NFPA 70E that requires arc-flash labelling shall be properly identified per NFPA 70E.

G. All overcurrent protective devices required to be selectively coordinated per NEC 700 shall be properly coordinated and device settings shall be included in panelboard and switchboard enclosures with the corresponding panel schedules.

1.07 SUBMITTALS

A. Product Data: Provide catalog data for nameplates, labels, and markers.

B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

C. Arc-Flash Hazards Calculation: Provide complete arc-flash hazards calculation per NFPA 70E to Owner's Representative and Engineer for review and approval.

D. Overcurrent Protective Device Coordination Study: Provide complete coordination study per NEC 700 to Owner's Representative and Engineer for review and approval.

E. Underground Conduit Ductbanks: Provide site plan with identification names/numbers of individual conduits, vaults, and handholes for Owner's Representative and Engineer's review and approval.

1.08 QUALITY ASSURANCE

A. Products: Listed and classified by Underwriters Laboratories (UL) as suitable for purpose specified as shown.

B. Comply with NFPA 70 and NFPA 70E.

1.09 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications and with those required by codes and standards.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and products in unopened factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from damage.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

A. Buried Electrical Lines: Underground warning tapes.

B. Communication Cabinets: Nameplates.

C. Conduit: Conduit Markers.

D. Electrical Distribution and Control Equipment Enclosures: Nameplates.

E. Transformers: Nameplates.

F. Junction Box Load Connections: Wire Markers.

G. Outlet Box Load Connections: Wire Markers.

H. Outlet Box Wall Cover Plates: Laser Etching.

I. Panel Gutter Load Connections: Wire Markers.

J. Pull Box Load Connections: Wire Markers.

K. Communication and Electrical Vaults: Nameplates.

2.02 NAMEPLATES AND LABELS

A. Manufacturers:

1. Marking Services, Inc. (MSI): http://www.markserv.com
2. Double O Laser Services, Inc.: http://www.doubleolaser.com
3. Or other reviewed and approved manufacturers.

B. Panelboard, Distribution Board, and Equipment Disconnect Nameplates: Engraved plastic, high contrast for maximum visibility. 1/16” engraving plastic with either mounting holes or adhesive backing.

1. Normal Power: White letters on black.
2. Emergency Power: Black letters on orange.
3. Panelboard and Distribution Board Labels:

Description:	Example:
Panel Name:	1M
Voltage:	480/277V
Amperes:	800A
Supplied From:	MSB-1

4. Equipment Disconnect Labels:

Description:	Example:
Equipment Name:	AHU-1
Voltage/Phase:	480V/3PH
Rated Load:	20HP
Supplied From:	PANEL 1M

C. Load Equipment Nameplates: Laser engraved black impression stainless steel with brushed satin finish & permanent black impression.

1. 430 Alloy, .029 thick.
2. 1/8” holes for attachment to equipment with stainless steel self-drilling screws.
3. Letter Size:
   a. Load Equipment Name: use 0.375-inch letters.
   b. All others: use 0.25-inch letters.

D. Labels: Embossed adhesive tape, with 3/16 inch white letters on black background. Use only for identification of individual wall switches, receptacles, control device stations.

E. Warning/Safety Labels: Industry standard self-adhesive warning/safety labels. Provide industry standard labeling, code required and per AHJ.

2.03 DEVICE AND JUNCTION BOXES

A. Manufacturer pre-painted junction box cover plates:

1. 480/277V Normal Power System: Yellow.

2. 208/120V Normal Power System: Blue.
3. Emergency Power System: Orange (painted inside and outside all other sides of box).
4. Fire Alarm System: Red (painted inside and outside all other sides of box).

B. Identify power circuits contained within junction boxes using permanent black ink marker with Panel Name and Circuit Number on cover plate of junction box.

2.04 OUTLET BOX COVER PLATES

A. Laser etched with panel name and circuit number on stainless steel cover plates. Laser etching shall be by Marking Services, Inc. (MSI). Refer to the following for examples:

Panel Name – Circuit Number - 2X4A – 22

Panel Name – Circuit Numbers - 1M4A – 1,3,5

2.05 CONDUCTOR IDENTIFICATION

A. Manufacturers:
1. Brady Corporation: Model (B-702).
2. Or other reviewed and approved Manufacturers.

B. Description: Vinyl cloth type self-adhesive wire markers.

C. Color: Black on White.

D. Legend:
1. Power and Lighting Circuits: Branch circuit or feeder number indicated on Drawings.

E. Wire Color Coding:
1. Single Phase, 3-Wire System: 120/240-Volt.
2. Three Phase, 4-Wire System: 120/208-Volt.
3. Three Phase, 4-Wire System: 277/480-Volt.
4. Equipment Ground Wire: Green.
5. Control wiring shall be black with identifying wire numbers at each termination.
6. Color-coded tape may be used in lieu of color-coded insulation for conductors #8 AWG and larger. However, when color coded tape is used, the conductor insulation shall be black only and shall be tape identified with color scheme shown above at splices, terminations, and junction boxes.

2.06 RACEWAY IDENTIFICATION

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Provide conduit identification at both ends of all Medium Voltage Conduits, Low Voltage Conduits, and Communications Conduits identifying systems contained within conduits and “to” location for other end of conduit. This requirement applies to both site underground conduits routed between vaults, buildings, and also conduits within Buildings.

2.07 CONDUIT MARKERS

A. Location: Furnish markers for each conduit longer than 6-feet (2m).

B. Spacing: 20-feet (6m) on center.

C. Color:
1. 480/277 Volt System: Yellow.
2. 208/120 Volt System: Blue.
3. Fire Alarm System: Red.
4. Telecommunication System: Gray.

D. Underground Conduit Entering Vaults:
   1. Brass conduit tags.
   2. .032-inch (20 gauge) brass.
   3. 3/16-inch hole for easy mounting.
   4. Top line 1/4-inch text with second line 1/2-inch number is standard.
   5. Tag shall identify conduit by system and location of other end of conduit. E.g., “FIBER – RM K104”. Identify “SPARE” for system for empty conduits.

2.08 UNDERGROUND WARNING TAPE

A. Underground Warning Tape: 3-inches (76 mm) wide polyethylene tape, detectable type colored red with suitable warning label describing buried electrical lines.

B. Warning tape shall be acid and alkali-resistant and shall have a minimum strength of 1,750 psi lengthwise and 1,500 psi crosswise, with an elongation factor of 350%.

2.09 WARNING/SAFETY LABELS

A. Self-adhesive, industry standard labels.

B. Provide labels per code requirements and per AHJ.

C. Provide the following label on front of all 208V or 240V Panelboards, Distribution Boards, and Switchboards:

CAUTION

AREA IN FRONT OF

ELECTRICAL PANEL

MUST BE KEPT CLEAR

FOR 36 INCHES

D. Provide the following label on front of all 480V Panelboards, Distribution Boards, and Switchboards:

CAUTION

AREA IN FRONT OF

ELECTRICAL PANEL

MUST BE KEPT CLEAR

FOR 48 INCHES

E. Provide the identification label/sign at all Emergency Power Off “EPO” pushbuttons, stating Panel Name pushbutton controls (shunts off).

2.10 CABLE TIES

A. General-Purpose Cable Ties: Fungus insert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon:
   1. Minimum width: 3/16”.
   2. Tensile strength at 73-degrees F, according to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185-degrees F.
   4. Color: Black.

2.11 MEDIUM-VOLTAGE (MV) CABLING IDENTIFICATION

A. Manufacturers:
   1. Marking Services, Inc. (MSI): http://www.markserv.com
   2. Or other reviewed and approved Manufacturers.

B. Provide identification tag on each cable, for each phase, at the following locations at minimum: each cable with load breaks in vaults, each cable looped in vaults, and each cable connecting to switches and transformers.

C. Description: Engraved plastic, high contrast for maximum visibility. 1/16” engraving plastic with either mounting holes and zip-tied to cables.

D. Color: White letters on black background.

E. Identification Text: Include the following: Voltage, From Location to Current Location, and Electrical Phase. Example: 12KV MH31 – T30 A

PART 3 EXECUTION

3.01 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Degrease and clean surfaces to receive nameplates and labels.

C. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

D. Apply identification devices to surfaces that require finish after completing finish work.

E. Self-Adhesive Identification Products: Clean surfaces before application, using materials, and methods recommended by manufacturer of identification device.

F. Attach sign and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

G. Attach plastic raceway and cable leads that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.

H. Install nameplates and labels parallel to equipment lines.

I. Secure nameplates to equipment front using screws or rivets.

J. Identify empty conduit at each end with permanent ink marker. Indicate function and termination location of other end.

K. Identify underground conduits using underground warning tape. Install one tape per trench at 3-inches, or as indicated in Drawings, below finished grade.

L. Each outdoor conduit shall be labeled with the location of the opposite end of the conduit, and numbered as C# (Where C stands for conduit and # is increased with each conduit in the set).
   1. For example, if 2 conduits are installed between vault 101 and vault 102, both conduits in vault 101 shall have a weatherproof label and be labeled “C1 To Vault 102” and “C2 To Vault 102” while both conduits in vault 102 shall be labeled “C1 To Vault 101” and “C2 To Vault 101” respectively. If a conduit ends in a building, the building name and room number shall be labeled as the destination.

3.02 COMMISSIONING REQUIREMENTS

A. The equipment and systems referenced in this Section shall be commissioned per Section 01 91 13 “General Commissioning Requirements” and per Section 26 08 00 “Commissioning of Electrical Systems”. The Contractor has specific responsibilities for scheduling, coordination, startup, test development, testing, and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.01 GENERAL

A. Conform to General Conditions, Supplementary Conditions, Division 01, and Division 26.

B. Review the Specifications and Drawings for coordination with additional requirements and information that applies to work under this Specification.

1.02 SUMMARY

A. Section Includes:

1. Straight-blade convenience, hospital-grade, isolated-ground, and tamper-resistant receptacles.
2. USB charger devices.
3. GFCI receptacles.
4. SPD receptacles.
5. Hazardous (classified) location receptacles.
6. Twist-lock receptacles.
7. Pendant cord-connector devices.
8. Cord and plug sets.
9. Toggle switches.
10. Decorator-style convenience devices.
11. Wall switch sensor light switches with dual-technology sensors.
12. Wall switch sensor light switches with passive-infrared sensors.
13. Wall switch sensor light switches with ultrasonic sensors.
14. Digital timer light switches.
15. Residential devices.
16. Wall-box dimmers.
17. Wall plates and gaskets.
18. Cable reels.
19. Floor service outlets.
20. Poke-through assemblies.
21. Prefabricated multioutlet assemblies.
22. Service poles.
23. 120V stand-alone fire alarm smoke and combination smoke/CO detectors with battery backup.

1.03 RELATED SECTIONS

A. Division 26 Section “Raceways and Boxes”.

B. Division 26 Section “Grounding and Bonding”.

C. Division 26 Section “Identification for Electrical Systems”.

1.04 REFERENCES

A. FS W-C-596 – Connector, Electrical, Power, General Specification for; Federal Specification; Revision G, 2001.

B. FS W-S-896 – Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification; Revision F, 1999.

C. NECA 1 – Standard for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; 2006.

D. NEMA WD 1 – General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2010).

E. NEMA WD 6 – Wiring Device – Dimensional Requirements; National Electrical Manufacturers Association; 2002 (R 2012).

F. NFPA 70 – National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by the Authority Having Jurisdiction, including all applicable amendments and supplements.

G. UL 20 – General-Use Snap Switches; Current Edition, including all revisions.

H. UL 498 – Attachment Plugs and Receptacles; Current Edition, including all revisions.

I. UL 514D – Cover Plates for Flush-Mounted Wiring Devices; Current Edition, including all revisions.

J. UL 943 – Ground-Fault Circuit-Interrupters; Current Edition, including all revisions.

K. UL 1449 – Standard for Surge Protective Devices; Current Edition, including all revisions.

L. UL 1472 – Solid-State Dimming Controls; Current Edition, including all revisions.

M. UL 1917 – Solid-State Fan Speed Controls; Current Edition, including all revisions.

1.05 DEFINITIONS

A. BAS: Building Automation System.

B. EMI: Electromagnetic Interference.

C. GFCI: Ground-Fault Circuit Interrupter.

D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

E. RFI: Radio-Frequency Interference.

F. SPD: Surge Protective Device.

G. UTP: Unshielded Twisted Pair.

1.06 SUBMITTALS

A. Submit under provisions of Division 01.

B. Submit catalog cuts for all items proposed to be furnished and installed under this Section.

C. Product Data: For each type of product, provide manufacturer’s catalog information showing dimensions, colors, and configurations.

1. Wall Dimmers: Include derating information for ganged multiple devices.
2. Surge Protection Receptacles: Include surge current rating, voltage protection rating (VPR), for all protection modes and diagnostics information.

D. Shop Drawings: List of legends and description of materials and processes used for premarking wall plates.

E. Samples: One for each type of device and wall plate specified, in each color specified.

F. Project Record Documents: Record actual installed locations of all wiring devices.

G. Maintenance Materials: Furnish the following for Owner’s use in maintenance of the Project:

1. Refer to Division 01 for additional provisions.
2. Service/Power Poles: One for every 10, but no fewer than one.
3. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.

4. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than one.
5. Screwdrivers for Tamper-Resistant Screws: Two of each type of screw.
6. Extra Keys for Locking Switches: Two of each type.
7. Extra Surge Protection Receptacles: Two of each type.
8. Extra GFC Protection Receptacles: Two of each type.
9. Extra Wall Plates: One of each style, size, and finish.

1.07 INFORMATION SUBMITTALS

A. Submit field quality-control reports.

1.08 CLOSEOUT SUBMITTALS

A. Operating and Maintenance Data: For wiring devices to include in all manufacturer's packing label warnings and instruction manuals that include labeling conditions.

1.09 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer's Qualifications: Company specializing in manufacturing the products specified in this Section with minimum three (3) years documented experience.

C. Provide products listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated for all wiring devices.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space, in original manufacturer's packaging until ready for installation.

1.11 COORDINATION

A. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other Sections or by others.

B. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.

C. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.

D. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.

E. Notify Owner's Representative of any conflicts or deviations from the Contract Documents to obtain direction prior to proceeding with work.

F. Do not install wiring devices until final surface finishes and painting are complete.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Hubbell Incorporated: www.hubbell-wiring.com

B. Leviton Manufacturing Company, Inc.: www.leviton.com

C. Pass & Seymour, a brand of Legrand North America, Inc.: www.legrand.us

D. Cooper Wiring Devices: www.cooperwiringdevices.com

2.02 APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.

B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.

C. Provide weather-resistant GFCI receptacles with specified weatherproof covers for all receptacles installed outdoors or in damp or wet locations.

D. Provide GFCI receptacles for all receptacles installed within 6-feet of sinks.

E. Provide GFCI receptacles for all receptacles installed in kitchens.

F. Provide GFCI receptacles for all receptacles serving electric drinking fountains.

G. Provide GFCI receptacles for all receptacles serving vending machines.

H. Provide GFCI receptacles in all restrooms/bathrooms located in both commercial and residential.

I. Provide GFCI receptacles for all receptacles in Commercial Garages, Repair and/or Storage per Article 511 of the National Electrical Code (NEC).

J. Unless noted otherwise, do not use combination switch/receptacle devices.

2.03 GENERAL WIRING-DEVICE REQUIREMENTS

A. Comply with NFPA 70.

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

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements of this Section.

D. Devices for Owner-Furnished Equipment:

1. Receptacles: match plug configurations.
2. Cord and Plug Sets: match equipment requirements.

E. Source Limitations: Obtain each type of wiring device and associated wall plate from a single source from a single manufacturer.

2.04 APPROVED PRODUCTS

DEVICE	LEVITON	HUBBELL	COOPER
1-POLE SWITCH	CSB1-20	1221	2221
3-WAY SWITCH	CSB3-20	1223	2223
4-WAY SWITCH	CSB4-20	1224	2224
DUPLEX RECEPTACLE	5362	5362	CR5362
DUPLEX GFCI RECEPTACLE	8899	GF5362	VGF20
DUPLEX TAMPER-RESISTANT RECEPTACLE	8200SG	GFR5362TR	TR8300

2.05 WALL SWITCHES

A. Comply with NEMA WD 1, NEMA WD 6, UL 20, and FS W-S-896.

B. All Wall Switches: AC only, quiet operating, general-use snap switches with silver alloy contacts; types as indicated on the Drawings.

1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

C. Switches: 120/277 V, 20 amp rated, in the following configurations:

1. Single Pole.
2. Two Pole.
3. Three Way.
4. Four Way.
5. Pilot-Light.
6. Key-Operated.

7. Single-Pole, Double-Throw, Momentary-Contact, Center-Off: for use with mechanically held lighting contactors.
8. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-Off: for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
9. Motor-rated toggle switches for motor duty shall be rated at minimum 2HP at 277V, 1HP at 120V.

2.06 STRAIGHT-BLADE RECEPTACLES

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

B. Single Receptacles: Heavy duty, grounding type, complying with NEMA WD 1 and WD 6.
   1. Ratings: Match branch circuit and load characteristics.

C. Duplex Receptacles: Heavy duty, specification grade, 20-ampere grounding type, 125 V, complying with NEMA WD 1 and WD 6, configuration 5-20R, UL 498, and FS W-C-596.
   1. One piece integral all brass mounting strap with back wired grounding terminal.
   2. Back and side wired conductor terminals.
   3. External wiring clamps with #10 large head brass screws.
   4. NEMA Configuration: 5-20R.

D. Hospital-Grade Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1 and WD 6, configuration 5-20R, UL 498, and FS W-C-596.

E. Isolated Ground Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1 and WD 6, configuration 5-20R, UL 498, and FS W-C-596.
   1. Description: straight-blade, equipment grounding contacts shall be concealed only to the green grounding screw terminal of the device and with inherent electrical isolation from the mounting strap. Isolation shall be integral to the receptacle construction and not dependent on removable parts.

F. Tamper-Resistant Duplex Convenience Receptacles: 25 V, 20 A; comply with NEMA WD 1 and WD 6, configuration 5-20R, UL 498, and FS W-C-596.
   1. Description: Labeled and complying with NFPA 70, “Health Care Facilities”, Article “Pediatric Locations” Section.

2.07 USB CHARGER DEVICES

A. Tamper-Resistant, USB Charger Receptacles: 12 V DC, 2.0 A, USB Type A; comply with NEMA WD 1 and WD 6, configuration 5-20R, UL 498, UL 1310, and FS W-C-596.
   1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
   2. USB Receptacles: Dual, Type A.
   3. Line Voltage Receptacles: Dual, two-pole, three-wire, and self-grounding.

B. Hospital-Grade, USB Charger Receptacles: 12 V DC, 2.0 A, USB Type A; comply with NEMA WD 1 and WD 6, configuration 5-20R, UL 498, UL 1310, and FS W-C-596.
   1. Description: Labeled and complying with NFPA 70, “Health Care Facilities”, Article “Pediatric Locations” Section.
   2. USB Receptacles: Dual, Type A.
   3. Line Voltage Receptacles: Dual, two-pole, three-wire, and self-grounding.

2.08 GFCI RECEPTACLES

A. General Description:

1. 125 V, 20 A, straight-blade, feed-through type.
2. Comply with NEMA WD 1 and WD 6, configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

2.09 SPD RECEPTACLES

A. General Description:

1. 125 V, 20 A, straight-blade type.
2. Comply with NEMA WD 1 and WD 6, configuration 5-20R, UL 498, UL 1449, and FS W-C-596.
3. Integral SPD in line to ground, line to neutral, and neutral to ground.
4. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
5. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is “active” or “no longer in service”.

B. Isolated-Ground, Duplex SPD Convenience Receptacles:

1. Grounding: Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from the mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.10 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Comply with NEMA FB 11 and UL 1010.

2.11 TWIST-LOCKING RECEPTACLES

A. Twist-Lock, Single Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1 and WD 6, configuration L5-20R or as specified on the Drawings, and UL 498.

B. Twist-Lock, Isolated-Ground, Single Convenience Receptacles: 125 V, 20A; comply with NEMA WD 1 and WD 6, configuration L5-20R or as specified on the Drawings, and UL 498.

1. Grounding: Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from the mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.12 PENDANT CORD-CONNECTOR DEVICES

A. Description:

1. Matching, locking-type plug and receptacle body connector.
2. NEMA WD 6, configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
3. Body: Nylon, with screw-open, cable-gripping jaws, and provisions for attaching external cable grip.
4. External Cable Grip: Woven, wire-mesh type, made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.13 CORD AND PLUG SETS

A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment

being connected.

2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with the green-insulating grounding conductor, and ampacity of at least 130-percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.14 CABLE REELS

A. Industrial grade, corrosion resistant steel, 20-amp, UL Listed, 45-foot cord.

B. Manufacturer: Hubbell HBL45123R220 series with 5-foot supply cord, 20-amp supply plug, and (2) duplex receptacles on the end of the cord.

2.15 DECORATOR-STYLE DEVICES

A. Convenience Receptacles: Square-face, 125 V, 20 A; comply with NEMA WD 1 and WD 6, configuration 5-20R, and UL 498.

B. Tamper-Resistant Convenience Receptacles: Square-face, 125 V, 20 A; comply with NEMA WD 1 and WD 6, configuration 5-20R, and UL 498.

1. Description: Labeled to comply with NFPA 70, “Receptacles, Cord Connectors, and Attachment Plugs (Caps)” Article, “Tamper-Resistant Receptacles in Dwelling Units” Section.

C. Weather-Resistant Convenience Receptacles: Square-face, 125 V, 20 A; comply with NEMA WD 1 and WD 6, configuration 5-20R, and UL 498.

D. GFCI Feed-Through Type, Convenience Receptacles: Square-face, 125 V, 20 A; comply with NEMA WD 1 and WD 6, configuration 5-20R, UL 498, and UL 943 Class A.

E. GFCI, Tamper-Resistant Convenience Receptacles: Square-face, 125 V, 20 A; comply with NEMA WD 1 and WD 6, configuration 5-20R, UL 498, and UL 943 Class A.

1. Description: Labeled to comply with NFPA 70, “Receptacles, Cord Connectors, and Attachment Plugs (Caps)” Article, “Tamper-Resistant Receptacles in Dwelling Units” Section.

F. Toggle Switches: Square-face, 120/277 V, 20 A; comply with NEMA WD 1, UL 20, and FS W-S-896.

1. Toggle switches for motor duty shall be rated at minimum 2HP at 277V, 1HP at 120V.

G. Lighted Toggle Switches: Square-face, 120/277 V, 20 A; comply with NEMA WD 1, and UL 20.

1. Description: with LED-lighted handle, illuminated when switch is off.

2.16 WALL SWITCH SENSOR LIGHT SWITCH, DUAL-TECHNOLOGY

A. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual-technology.

1. Connections:
   a. Provisions for connection to BAS.
   b. Hard wired.
   c. Wireless.
2. Rated 960 W at 120 VAC for tungsten lighting, 10 A at 120/277 VAC for fluorescent or LED lighting, and 1/4 hP at 120 VAC.
3. Integral relay for connection to BAS.
4. Adjustable time delay; 5, 10, 15, or 20 minutes and set at 20 minutes.
5. Able to be locked to Automatic-On or Manual-On mode.
6. Automatic Light-Level Sensor: Adjustable from 2 to 200 footcandles.
7. Comply with NEMA WD 1, UL 2, and FS W-S-896.

2.17 WALL SWITCH SENSOR LIGHT SWITCH, PASSIVE-INFRARED

A. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using passive-infrared.

1. Connections:
    a. Provisions for connection to BAS.
    b. Hard wired.
    c. Wireless.
2. Rated 960 W at 120 VAC for tungsten lighting, 10 A at 120/277 VAC for fluorescent or LED lighting, and 1/4 hP at 120 VAC.
3. Integral relay for connection to BAS.
4. Adjustable time delay; 5, 10, 15, or 20 minutes and set at 20 minutes.
5. Able to be locked to Automatic-On or Manual-On mode.
6. Automatic Light-Level Sensor: Adjustable from 2 to 200 footcandles.
7. Comply with NEMA WD 1, UL 2, and FS W-S-896.

2.18 WALL SWITCH SENSOR LIGHT SWITCH, ULTRASONIC

A. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using ultrasonic.

1. Connections:
    a. Provisions for connection to BAS.
    b. Hard wired.
    c. Wireless.
2. Rated 960 W at 120 VAC for tungsten lighting, 10 A at 120/277 VAC for fluorescent or LED lighting, and 1/4 hP at 120 VAC.
3. Integral relay for connection to BAS.
4. Adjustable time delay; 5, 10, 15, or 20 minutes and set at 20 minutes.
5. Able to be locked to Automatic-On or Manual-On mode.
6. Automatic Light-Level Sensor: Adjustable from 2 to 200 footcandles.
7. Comply with NEMA WD 1, UL 2, and FS W-S-896.

2.19 DIGITAL TIMER LIGHT SWITCH

A. Description: Switchbox-mounted, combination digital timer and conventional switch lighting-control unit, with backlit display, with selectable time interval in 10-minute increments.

1. Rated 960 W at 120 VAC for tungsten lighting, 10 A at 120/277 VAC for fluorescent or LED lighting, and 1/4 hP at 120 VAC.
2. Integral relay for connection to BAS.

2.20 RESIDENTIAL DEVICES

A. Residential-Grade, Tamper-Resistant Convenience Receptacles: 125 V, 15 A; comply with NEMA WD 1 and WD 6, configuration 5-15R, and UL 498.

1. Description: Labeled to comply with NFPA 70, “Receptacles, Cord Connectors, and Attachment Plugs (Caps)” Article, “Tamper-Resistant Receptacles in Dwelling Units” Section.

B. Residential-Grade, Weather-Resistant and Tamper-Resistant Convenience Receptacles: 125 V, 15 A; comply with NEMA WD 1 and WD 6, configuration 5-15R, and UL 498.

1. Description: Labeled to comply with NFPA 70, “Receptacles, Cord Connectors, and Attachment Plugs (Caps)” Article, “Tamper-Resistant Receptacles in Dwelling Units” Section,

when installed in wet and damp locations.

C. Fan-Speed Controls:
   1. Modular, 120 V, full-wave, solid-state units with integral, quiet on-off switches, and audible frequency and EMI/RFI filters.
   2. Comply with UL 1917.
   3. Continuously adjustable rotary knob, 5 amps.
   4. Three-speed adjustable rotary knob, 1.5 amps.

D. Telephone Outlets:
   1. Description: Single RJ-45 jack for terminating Category 5e, twisted pair cable complying with Section 26 05 23 “Control-Voltage Electrical Power Cables” and Section 27 15 13 “Communications Copper Horizontal Cabling”.
   2. Comply with UL 1863.

E. Combination TV and Telephone Outlets:
   1. Description: Single RJ-45 jack for terminating Category 5e, twisted pair cable complying with Section 26 05 23 “Control-Voltage Electrical Power Cables” and a single BNC connector for terminating coaxial cable complying with Section 27 15 33 “Communications Coaxial Horizontal Cabling”.
   2. Description: Single RJ-45 jack for terminating Category 5e, twisted pair cable complying with Section 27 15 13 “Communications Copper Horizontal Cabling” and a single BNC connector for terminating coaxial cable complying with Section 27 15 33 “Communications Coaxial Horizontal Cabling”.
   3. Comply with UL 1863.

2.21 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider, with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmer Switches: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
   1. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when “off”.

D. Fluorescent Lamp Dimmer Switches: Modular, compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20-percent of full brightness.

E. LED Dimmer Switches: Modular, compatible with LED drivers; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 20-percent of full brightness.

2.22 COVER PLATES AND GASKETS

A. All cover plates shall comply with UL 514D.
   1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
   2. Size: Standard or as otherwise indicated.
   3. Screws: Metal with slotted heads finished to match wall plate finish.

B. Single and combination types shall match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Finished Spaces: 0.035-inch thick, satin finished, Type 302 Stainless Steel.
3. Materials for Unfinished Spaces: Galvanized Steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

C. Interior Device Cover Plates:

1. 302 Stainless Steel, with laser etching marking panel name and circuit number. Refer to Section 26 05 53 “Identification for Electrical Systems” for more information.
2. Receptacle cover plates for special use shall be pre-marked by the manufacturer:
   a. UPS
   b. UPS – COMPUTER
   c. ISOLATED GROUND
   d. GFCI PROTECTED

D. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

E. Exterior Device Cover Plates: Wiring devices installed outdoors or wet areas shall be provided with hinged, gasketed, weatherproof covers.

F. Exterior Receptacle Hinged Covers: Exterior receptacles accessible to the general public (building exterior at grade, etc.) shall be installed in flush cast aluminum outlet covers with hinged cover and keyed lock. Approved manufacturer: Pass & Seymour Catalog No. 4600.

G. Cover Plate Gaskets: Manufacturer’s standard sound-isolating and fire-protective molded neoprene complying with ASTM D 2000, formed to fit the electrical device and cover plate.

1. Basis-of-Design Product: Subject to compliance with requirements, provide STC Sound Control; STC Box Seal or comparable product by one of the following:
   a. Trademark Soundproofing.
   b. Or approved equal.
2. Sound Rating: Cover plate gaskets to improve STC of recessed outlets by 7 dB or higher.
3. Fire Rating: UL listed as Wall Opening Protective Device for use in 1-hour fire-rated walls, including back-to-back outlets.

2.23 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communications cabling.

C. Service Plates: Round, die-cast aluminum with satin finish.

D. Power Receptacles: NEMA WD 6, configuration 5-20R, white finish unless otherwise indicated.

E. Data Communications Outlets: Two modular, keyed, color-coded, RJ-45 jacks for twisted pair cabling complying with requirements in Section 27 15 13 “Communications Copper Horizontal Cabling”.

2.24 POKE-THROUGH ASSEMBLIES

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

1. Hubbell Incorporated; Wiring Devices-Kellems.
2. Pass & Seymour.
3. Square D; by Schneider Electric.
4. Wiremold/Legrand.

B. Description:

1. Factory-fabricated and –wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
2. Comply with UL 514 scrub water exclusion requirements.
3. Service-Outlet Assembly: Flush type with two duplex receptacles and space for four RJ-45 jacks complying with requirements in Section 27 15 13 “Communications Copper Horizontal Cabling”.
4. Size: Selected to fit nominal 4-inch cored holes in floor and matched to floor thickness.
5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
6. Closure Plug: Arranged to close unused 4-inch cored openings and reestablish fire rating of the floor.
7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors with a minimum of four, four-pair cables that comply with requirements in Section 27 15 13 “Communications Copper Horizontal Cabling”.

2.25 PREFABRICATED MULTIOUTLET ASSEMBLIES

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

1. Hubbell Incorporated; Wiring Devices-Kellems.
2. Wiremold/Legrand.
3. Or approved equal.

B. Description:

1. Two-piece, surface metal raceway, with factory-wired multioutlet harness.
2. Components shall be products from a single manufacturer, designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer’s standard finish.

D. Multioutlet Harness:

1. Receptacles: 20 A, 125 V, NEMA WD 6, configuration 5-20R receptacles, complying with NEMA WD 1, UL 498, and FS W-C-596.
2. Receptacle Spacing: 9-inches on center.
3. Wiring: No. 12 AWG solid, type THHN copper, two-circuit, connecting alternating receptacles.

2.26 SERVICE POLES

A. Description:

1. Factory-assembled and –wired units to extend power, voice, and data communications from distribution wiring concealed in ceiling to devices or outlets in a pole near the floor.
2. Poles: Nominal 2.5-inch square cross section, with height adequate to extend from floor to at least 6-inches above ceiling, and with separate channels for power wiring and voice/data communications cabling.
3. Mounting: Ceiling trim flange, with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
4. Finishes: Manufacturer’s standard painted finish and trim combination.
5. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, four-pair, Category 3 or Category 5e voice and data communications cables.
6. Power Receptacles: Two duplex, 20 A, straight-blade receptacles complying with requirements in this Section.

7. Data Communications Outlets: Four Rj-45 jacks complying with requirements in Section 27 15 13 “Communications Copper Horizontal Cabling”.

2.27 FINISHES

A. Device Color:
   1. Wiring Devices Connected to Normal Power System: White, or as selected by the Architect, or as otherwise indicated.
   2. Wiring Devices Connected to Emergency Power System: Red.
   3. SPD Devices: Blue.
   4. Isolated-Ground Receptacles: Orange or with Orange triangle on face.

B. Cover Plate Color: For plastic covers, match device color, otherwise 302 stainless steel.

2.28 STAND-ALONE FIRE ALARM SMOKE DETECTION AND COMBINATION SMOKE/CO DETECTION

A. Electrical Contractor to include 120V stand-alone fire alarm smoke detectors with 9V battery backup in all sleeping rooms or as required by Authority Having Jurisdiction, NFPA 72 - National Fire Alarm Code and Signaling Code, NFPA 101 - Safety to Life from Fire in Buildings, and local codes.

B. Electrical Contractor to include 120V stand-alone fire alarm combination smoke/CO detectors with 9V battery backup in outside of sleeping rooms, and each level or as required by Authority Having Jurisdiction, NFPA 72 - National Fire Alarm Code and Signaling Code, NFPA 101 - Safety to Life from Fire in Buildings, and local codes. If a hall or area is more than 30 feet long, install a unit at each end.

C. Electrical Contractor to make sure that no 120V stand-alone fire alarm smoke or combination smoke/CO detectors is with than 10-feet of the kitchen range and microwave as required by Authority Having Jurisdiction, NFPA 72 - National Fire Alarm Code and Signaling Code, NFPA 101 - Safety to Life from Fire in Buildings, and local codes.

D. Electrical Contractor to provide a dedicated circuit with a lock on device on the circuit breaker for these detectors. Label circuit breaker “FA UNIT SMOKE/CO”.

E. Provide tandem wiring between each 120V stand-alone smoke detector in a single dwelling unit. So that if any one smoke detector in the dwelling unit is triggered all other smoke detectors will alarm with that dwelling unit.

F. MANUFACTURERS
   1. BRK Electrics: www.brkelectronics.com
   2. Kidde: www.kidde.com
   3. Gentex: www.gentex.com
   4. Or other reviewed and approved Manufacturers.

PART 3 EXECUTION

3.01 EXAMINATION

A. Device or equipment mounting height given herein the Specifications, Drawings, and/or Contract Documents, are intended to provide general guidelines pursuant to industry standards. Such guidelines may not be exact or accurate and may or may not conflict with other trades installation without verification. Provide field coordination and verification with other divisions.
   1. Verify counter heights with cabinet installer and cabinet shop drawings, prior to rough-in for outlets.
   2. Examine other trades shop drawings to ensure that such mounting heights are appropriate for the intended device use, and the device locations do not conflict with other components. Immediately report impaired device use and conflict/location to the Owner’s Representative

for resolution. Devices may be moved up to 20-feet without additional compensation.

3. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

B. Verify that final surface finishes are complete, including painting.

1. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

C. The Drawings are diagrammatic and indicate generally the locations of materials, equipment, and devices. These Drawings shall be followed as closely as possible.

1. Coordinate the work under this Section with the Architectural, Structural, Plumbing, Heating and Air-Conditioning, and the drawings of other trades for exact dimensions, clearances, and roughing-in locations.

2. Cooperate with other trades in order to make minor field adjustments to accommodate the work of others.

3. Devices and outlets can be field located by Owner's Representative within 20-feet of the designed locations prior to rough-in work, without extra compensation.

3.03 INSTALLATION

A. Comply with NECA 1, including mounting heights listed, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint, unless the joint is troweled flush with the face of the wall.

4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

4. Existing conductors (where applicable):

a. Cut back and pigtail.

b. Replace all damaged conductors.

c. Straighten conductors that remain and remove corrosion and foreign matter.

d. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Install wiring devices plumb and level with mounting yoke held rigidly in place.

E. Install wall switches with OFF position down.

F. Install two or more wiring devices shown in one location under a common cover plate. Install cover plates with edges in continuous contact with finished wall surfaces. Do not install more than one device in a single gang position.

G. Before installation rough-in, device locations may be revised by the Owner's Representative within 20-feet of the designed contract location, at no additional cost.

H. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package, or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6-inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3s to 3/4s of the way around the terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-amp circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device(s).
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in the yokes, allowing metal-to-metal contact.

I. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles at the bottom, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

J. Device Cover Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

K. Cover Plate Gaskets: Place gasket over exposed outlet boxes flush with wall surface with device protruding through precut opening in seal. Fit cover plate over gasket and hold in place with plate-securing screws.

L. Dimmer Switches:

1. Install dimmer switches within terms of their listing.
2. Verify that dimmer switches used for fan-speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturer's device listing conditions in the written instructions.

M. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on bottom. Group adjacent switches under single, multi-gang cover plates.

N. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.04 GFCI RECEPTACLES

A. Install non-feed through-type GFCI receptacles where protection of downstream receptacles are not required.

3.05 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Division 01.

B. Inspect each wiring device for damage and defects.

C. Operate each wall switch, dimmer switch, and fan speed controller with circuit energized to verify proper operation.

D. Test each receptacle to verify operation and proper polarity.

E. Test Instruments: Use instruments that comply with UL 1436.

F. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital display indicators of measurement.

G. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-amp Load: A value of 6-percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

H. Test straight-blade convenience outlets in patient-care areas for the retention force of the grounding-blade according to NFPA 99. Retention force shall not be less than 4 oz.

I. Wiring devices will be considered defective if they do not pass tests and inspections.

J. Correct wiring deficiencies and replace damaged or defective wiring devices.

K. Prepare test and inspection reports.

3.06 ADJUSTING

A. Adjust devices and cover plates to be flush and level.

3.07 IDENTIFICATION

A. Comply with Section 26 05 53 “Identification for Electrical Systems”.

B. Identify each receptacle with panelboard and circuit number identification. Use hot, stamped, or engraved machine printing with black-filled lettering on face of cover plate, and durable wire markers or tags inside outlet boxes.

END OF SECTION

SECTION 26 28 13
FUSES

PART 1 GENERAL

1.01 GENERAL

A. Conform to General Conditions, Supplementary Conditions, Division 01, and Division 26.

B. Review the Specifications and Drawings for coordination with additional requirements and information that applies to work under this Specification.

1.02 SUMMARY

A. Furnish and install fuses having the electrical characteristics, ratings, and modifications as specified herein and as shown on the Drawings.

1.03 RELATED SECTIONS

A. Division 26 Section “Identification for Electrical Systems”.

B. Division 26 Section “Enclosed Switches”.

1.04 REFERENCES

A. NEMA FU 1 – Low-Voltage Cartridge Fuses; National Electrical Manufacturers Association; 2002 (R 2007).

B. NFPA 70 – National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by the Authority Having Jurisdiction, including all applicable amendments and supplements.

C. UL 248-1 – Low-Voltage Fuses – Part 1: General Requirements; Current Edition, including all revisions.

1.05 SUBMITTALS

A. Submit under provisions of Division 01.

B. Submit catalog cuts for all items proposed to be furnished and installed under this Section.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Bussman by Eaton: http://www.cooperindustries.com/content/public/en/products/fuses.html

B. Or other reviewed and approved Manufacturers.

2.02 FUSES

A. Comply with UL 248-1.

B. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.

C. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required by serving equipment manufacturer for a complete operating system.

D. Provide fuses of the same type, rating, and manufacturer within the same disconnect switch.

E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, class and ratings as indicated.

F. Voltage Rating: Suitable for circuit voltage.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

B. Verify that conditions are satisfactory for the installation prior to starting work.

3.02 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Provide fuses for equipment containing fuse-holders, including equipment furnished by other Divisions. Size motor branch circuit fuses in accordance with the rating of the motor served. Size fuses for equipment circuits in accordance with the branch circuit rating.

C. Install fuses with label oriented such that manufacturer, type, and size are easily able to be read.

D. Provide duplicate sets (3 fuses per set) of spare fuses of each type and rating at the completion of the Project.

E. Provide spare fuses and fuse cabinet installed at location directed by Owner.

END OF SECTION

SECTION 26 28 16
ENCLOSED SWITCHES

PART 1 GENERAL

1.01 GENERAL

A. Conform to General Conditions, Supplementary Conditions, Division 01, and Division 26.

B. Review the Specifications and Drawings for coordination with additional requirements and information that applies to work under this Specification.

1.02 SUMMARY

A. Furnish and installed the Enclosed Safety Switches having the electrical characteristics, ratings, and modifications as specified herein and as shown on the Drawings.

1.03 RELATED SECTIONS

A. Division 26 Section “Grounding and Bonding”.

B. Division 26 Section “Identification for Electrical Systems”.

C. Division 26 Section “Fuses”.

D. Division 26 Section “Hangers and Supports for Electrical Systems”.

1.04 REFERENCES

A. NECA 1 – Standard for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; 2006.

B. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.

C. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; 2001 (R 2006).

D. NETA STD ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.

E. NFPA 70 – National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, including all applicable amendments and supplements.

F. UL 50 – Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, including all revisions.

G. UL 50E – Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, including all revisions.

H. UL 98 – Enclosed and Dead-Front Switches; Current Edition, including all revisions.

1.05 SUBMITTALS

A. Submit under Provisions of Division 01.

B. Product Data: Provide manufacturer’s standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

C. Project Record Documents: Record actual locations of installed enclosed switches.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer’s instructions. One (1) copy of the manufacturer’s instructions shall be included with the equipment at time of shipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Cutler-Hammer.

B. Siemens.

C. Square D (Schneider Electric).

D. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer and Owner.

2.02 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break, enclosed safety switches complying with NEMA KS 1, type HD (heavy duty), and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the Drawings.

B. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,000 feet (2,000 m).
2. Ambient Temperature: Between -22 degrees F (-30 deg C) and 104 degrees F (40 deg C).

D. Horsepower Rating: Suitable for connected load(s).

E. Voltage Rating: Suitable for circuit voltage.

F. Short-Circuit Current Rating:

1. Provide enclosed safety switches, when protected by fuses or supply side overcurrent protective devices to be installed, with listed short-circuit current rating (SCCR) not less than the available fault current at the installed location as indicated on the Drawings.
2. Minimum Ratings: 18k AIC.

G. Provide with switch blade contact position that is visible when the cover is open.

H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.

1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

I. Conductor Terminations: Suitable for use with the conductors to be installed.

J. Provide insulated, groundable, fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

K. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

L. Enclosures: Comply with NEMA ICS 6, NEMA KS 1 and NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: NEMA-1.
   b. Indoor Dirty/Dusty, Dry Locations: NEMA-12.
   c. Outdoor and Indoor Wet Locations: NEMA-3R.

M. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

N. Heavy-Duty Switches:

1. Conductor Terminations:
    a. Provide mechanical lugs unless otherwise indicated.
    b. Provide compression lugs where indicated.
    c. Lug Material: Copper, suitable for terminating copper conductors only.
2. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

O. Switches shall be equipped with the number of poles, voltage and current rating required for the equipment being served.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install enclosed switches in accordance with the manufacturer's instructions.

B. Install enclosed safety switches securely, in a neat workmanlike manner and in accordance with NECA-1.

C. Arrange equipment to provide minimum clearances in accordance with the manufacturer's instructions and NFPA 70.

D. Provide required supports in accordance with Section 26 05 29 "Hangers and Supports for Electrical Systems".

E. Install enclosed switches level and plumb.

F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79-inches (2000 mm) above the floor or working platform.

G. Provide grounding and bonding in accordance with Section 26 05 26 "Grounding and Bonding".

H. Provide fuses complying with Section 26 28 13 "Fuses" for fusible switches as indicated or as required by the equipment manufacturer's recommendations.

I. Provide identification nameplate for enclosed switches in accordance with Section 26 05 53 "Identification for Electrical Systems".

J. Provide identification label on inside door of each fused switch indicated NEMA fuse class, rating, and size. Install label in accordance with Section 26 05 53 "Identification for Electrical Systems".

K. Provide arc flash warning labels in accordance with NFPA 70E.

L. Provide disconnect switches as indicated on the Drawings, Schedules, at motors, motor driven equipment, motor controllers, electric heating equipment, appliances, and other equipment, unless the equipment has self-contained, code approved disconnecting method.

M. Mounting: Coordinate mounting location with equipment installation Contractor. In general, mounting height shall be 72-inches, maximum to top of switch.

3.02 FIELD QUALITY CONTROL

A. Perform field inspection in accordance with Division 01.

B. Inspect and test in accordance with NETA STD ATS, except Section 4.

C. Perform inspections and tests listed in NETA STD ATS, Section 7.5.1.1.

D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.03 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.04 CLEANING

A. Clean dirt and debris from switch enclosure and components according to manufacturer's instructions.

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

END OF SECTION