

ELECTRICAL SPECIFICATION INDEX

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SECTION 16010 - BASIC ELECTRICAL REQUIREMENTS

1. PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Basic Electrical Requirements specifically applicable to Division 16 Sections.
- B. The electrical contractor shall provide all labor, materials tools, transportation, equipment, services, and facilities required for the complete and proper installation of all electrical work shown on the Drawings and/or outlined in these Specifications. Work shall include all materials, appliances, and apparatus not specifically mentioned herein or noted on the plans but necessary to make a complete working installation of all electrical systems shown or described herein.

1.2 WORK SEQUENCE

- A. Install work in stages during the construction period and coordinate electrical schedule and operations with other contractors doing work of various trades employed in construction of the building. Refer to Construction Drawings and Specifications for details.

1.3 ALTERNATES

- A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the Engineer's option. Accepted Alternates will be identified in Owner-Contractor Agreement.
- B. Coordinate related work and modify surrounding work as required.

1.4 SUBMITTALS

A. SUBMITTAL PROCEDURES

1. Transmit each submittal with Architect/Engineer accepted form.
2. Sequentially number the transmittal forms. Resubmittals to have original number with a decimal suffix. (ie: Submittal #5.3)
3. Identify Project, Contractor, Subcontractor or supplier; pertinent Drawing sheet and detail number(s), and specification Section number, as appropriate.
4. Apply Contractor's stamp, signed or initialled certifying that review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.
5. Schedule submittals to expedite the Project, and deliver to Architect/Engineer at business address.
6. Identify variations from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed Work.
7. Provide space for Contractor and Architect/Engineer review

stamps.

8. Revise and resubmit submittals as required, identify all changes made since previous submittal.
9. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

B. PROPOSED PRODUCTS LIST AND DATA

1. Within 15 days after date of Owner-Contractor Agreement, submit complete list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
2. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.
3. Submit the number of copies which the General Contractor requires, plus two copies which will be retained by the Engineer.
4. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information unique to this Project.
5. After review, distribute in accordance with Article on Procedures above and provide copies for Record Documents described below - Contract Closeout.

C. SHOP DRAWINGS

1. Submit the number of opaque reproductions which General Contractor requires, plus two copies which will be retained by Engineer.
2. Distribute in accordance with Record Documents described below - Contract Closeout.

1.7 QUALITY CONTROL

A. QUALITY ASSURANCE/CONTROL OF INSTALLATION

1. Monitor quality control over suppliers, manufacturers, Products, services, site conditions, and workmanship, to produce Work of specified quality.
2. Comply fully with manufacturer's instructions, including each step in sequence.
3. Should manufacturer's instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
4. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
5. Perform work by persons qualified to produce workmanship of

specified quality.

6. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.
7. The engineer reserves the right to reject any material not in accordance with the drawings and specifications. Specific brands, names, and catalog numbers are used in connection with materials to establish standards of performance and quality. The contractor shall not substitute other materials without written permission from the Engineer. Decision of the Engineer shall govern as to what may be substituted, but burden of proof as to quality of any proposed substitution shall be upon the contractor. If the Engineer or Owner finds that any material does not conform with these specifications, this Contractor shall, within three days after being notified by the Engineer, remove the material from the premises. If said material has been installed, the entire expense of removing and replacing same, including any cutting and patching that may be shall be borne by this Contractor. Work shall not be closed in or covered before inspection and approval by engineer or his representative. Costs of uncovering and making repairs where uninspected work has been closed in, shall be borne by this section.

#### B. REFERENCES

1. Unless otherwise specified, conform to reference standard by date of issue current on date of Contract Documents.
2. Should specified reference standards conflict with Contract Documents, request clarification for Architect/Engineer before proceeding.
3. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.
4. National Electrical Code (NFPA 70)(1999 Edition) with California Amendments(California Electric Code CEC 2001 Edition).
5. National Fire Protection Association (NFPA)
6. Uniform Building Code (UBC)
7. Underwriter's Laboratory (UL)
8. American National Standards Institute (ANSI)
9. National Electrical Manufacture's Association (NEMA)
10. Uniform Fire Code
11. City Ordinances
12. Pacific Gas & Electric - Electric Service Requirements (PG&E)

#### 1.9 MATERIAL AND EQUIPMENT

A. PRODUCTS

1. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse.
2. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.

B. TRANSPORTATION AND HANDLING

1. Transport and handle products in accordance with manufacturer's instructions.
2. Promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.
3. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

C. STORAGE AND PROTECTION

1. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate controlled enclosures.
2. For exterior storage of fabricated products, place on sloped supports, above ground.
3. Provide off-site storage and protection when site does not permit on-site storage or protection.
4. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.
5. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
6. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.

D. PRODUCT OPTIONS

1. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer or product not named.

E. SUBSTITUTIONS

1. The Engineer will consider requests for Substitutions only within 15 days after date of Owner-Contractor Agreement.
2. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.

3. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
4. A request constitutes a representation that the Contractor:
  - a. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
  - b. Will provide the same warranty for the Substitution as for the specified product.
  - c. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
  - d. Waives claims for additional costs or time extension which may subsequently become apparent.
  - e. Will reimburse Owner for review or redesign services associated with re-approval by authorities.
5. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
6. Substitution Submittal Procedure:
  - a. Submit three copies of request for Substitution for consideration. Limit each request to one proposed Substitution.
  - b. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence.
  - c. The Engineer will notify Contractor, in writing, of decision to accept or reject request.

#### 1.10 STARTING OF SYSTEMS

##### A. STARTING SYSTEMS

1. Coordinate schedule for start-up of various equipment and systems.
2. Notify Architect/Engineer and Owner seven days prior to start-up of each item.
3. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.
4. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
5. Verify wiring and support components for equipment are complete and tested.
6. Execute start-up under supervision of responsible Contractors' personnel in accordance with manufacturers' instructions.
7. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

B. DEMONSTRATION AND INSTRUCTIONS

1. Demonstrate operation and maintenance of Products to Owner's personnel two weeks prior to date of final inspection.
2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

1.11 CONTRACT CLOSEOUT

A. CLOSEOUT PROCEDURES

1. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's inspection.
2. Provide submittals to Engineer and Owner that are required by governing or other authorities.

B. FINAL CLEANING

1. Execute final cleaning prior to final inspection.
2. Clean equipment and fixtures to a sanitary condition.
3. Remove waste and surplus materials, rubbish, and construction facilities from the site.

C. PROJECT RECORD DOCUMENTS

1. Maintain on site, one set of the following record documents; record actual revisions to the Work:
  - a. Contract Drawings.
  - b. Specifications.
  - c. Addenda.
  - d. Change Orders and other Modifications to the Contract.
2. Reviewed shop drawings, product data, and samples.
3. Store Record Documents separate from documents used for construction.
4. Record information concurrent with construction progress.
5. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:
  - a. Manufacturer's name and product model and number.
  - b. Product substitutions or alternates utilized.
  - c. Changes made by Addenda and Modifications.
    - a) Record Documents and Shop Drawings: Legibly mark each item to record actual construction including
  - d. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
  - e. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and

- accessible features of the Work.
- f. Field changes of dimension and detail.
- g. Details not on original Contract Drawings.

D. WARRANTIES

1. Provide one year warranty on all material and labor installed and provide one year free of charge to the owner replacement labor and material for the above warranty.
2. Lamps are exempt to one year warranty.

1.12 REGULATORY REQUIREMENTS

- A. Conform to applicable Uniform Building Code.
- B. Conform to NFPA 70.
- C. Conform to Local Ordinances and Regulations.
- D. Request inspections from authority having jurisdiction. Note: Electrical permit is required before the start of any electrical work. Contractor shall provide 48 hour prior notification to the electrical inspector for all scheduled inspections or power outages.
- E. Furnish products listed and classified by underwriters Laboratories, Inc. and testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.
- F. Should there be any conflicts between the Drawings, Specifications, or Regulatory Requirements; the most stringent condition shall govern, unless approved by the Engineer.
- G. Furnish without extra charge additional materials and labor which may be required for compliance with these laws, rules and regulations even though the work is not mentioned in these specifications or shown on the Drawings.

1.13 PROJECT/SITE CONDITIONS

- A. Install Work in locations shown on Drawings, unless prevented by Project conditions.
- B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Engineer before proceeding.

2. PART 2 PRODUCTS

1. Not Used

3. PART 3 EXECUTION

1. Not Used

END OF SECTION 16010

SECTION 16110 - RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions apply to this Section.
- B. Requirements of the following Division 16 Sections apply to this Section:
  - 1. "Basic Electrical Requirements."

1.2 SUMMARY

- A. This Section includes raceways for electrical wiring. Types of raceways in this section include the following:
  - 1. Electrical metallic tubing (EMT).
  - 2. Liquidtight flexible conduit.
  - 3. Rigid metal conduit.
  - 4. Rigid nonmetallic conduit.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data for the following products:
  - 1. Surface raceway and fittings.
  - 2. Wireway and fittings.
- D. Installation Instructions: Manufacturer's written installation instructions for wireway, surface raceway, and nonmetallic raceway products.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 with California Amendments "California Electrical Code."
- B. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
- C. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL, ETL, or CSA.

### 1.5 SEQUENCING AND SCHEDULING

- A. Coordinate with other Work, including metal and concrete work, as necessary to interface installation of electrical raceways and components with other Work.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
  - 1. Adalet-PLM
  - 2. American Electric
  - 3. Appleton Electric Co.
  - 4. Carlon
  - 5. Crouse-Hinds Division, Cooper Industries, Inc.
  - 6. Delta Industrial Products
  - 7. Killark Electric Mfg. Co.
  - 8. Kraloy Products Co.
  - 9. O-Z/Gedney
  - 10. Spring City Electrical Mfg. Co.
- B. Conduit Bodies:

### 2.2 METAL CONDUIT AND TUBING

- B. Rigid Galvanized Steel Conduit: ANSI C80.1.
- E. Electrical Metallic Tubing and Fittings: ANSI C80.3.

### 2.3 NONMETALLIC CONDUIT AND DUCTS

- B. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.
- C. PVC Conduit and Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.
- F. Liquidtight Flexible Nonmetallic Conduit and Fittings: UL 1660. Fittings shall be specifically approved for use with this raceway.
- G. Conduit, Tubing, and Accessories: Types, sizes, and materials complying with manufacturer's published product information. Mate and match accessories with raceway.

## 2.4 CONDUIT BODIES

- A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.
- B. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways.
- C. Conduit Bodies 1 Inch and Smaller: Use bodies with compression- type EMT connectors.
- D. Nonmetallic Conduit and Tubing: Use nonmetallic conduit bodies conforming to UL 514 B.

## PART 3 - EXECUTION

### 3.1 WIRING METHOD

- A. Outdoors: Use the following wiring methods:
  - 1. Exposed: Rigid Galvanized Steel metal conduit.
  - 2. Concealed: Rigid Galvanized Steel metal conduit.
  - 3. Underground: rigid nonmetallic conduit.
  - 4. Indoors or Outdoors: Connection to vibrating equipment and hydraulic, pneumatic, or electric solenoid or motor-driven equipment in moist or humid location or corrosive atmosphere, or where subject to water spray or dripping oil, grease, or water: liquidtight flexible metal conduit.
- B. Indoors: Use the following wiring methods:
  - 1. Indoors or Outdoors: Connection to vibrating equipment and hydraulic, pneumatic, or electric solenoid or motor-driven equipment in moist or humid location or corrosive atmosphere, or where subject to water spray or dripping oil, grease, or water: liquidtight flexible metal conduit.
  - 2. Exposed: electrical metallic tubing or rigid galvanized steel conduit.
  - 3. Concealed: electrical metallic tubing or rigid galvanized steel conduit.

### 3.2 INSTALLATION

- A. General: Install electrical raceways in accordance with manufacturer's written installation instructions, applicable requirements of NEC, and as follows:
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.
- C. Elevation of Raceway: Where possible, install horizontal raceway runs above

water and mechanical piping.

- D. Complete installation of electrical raceways before starting installation of conductors within raceways.
- E. Provide supports for raceways as specified elsewhere in Division 16.
- F. Prevent foreign matter from entering raceways by using temporary closure protection.
- G. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- H. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
- I. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location.
- L. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.
- M. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways be of the same size. In other cases provide field bends for parallel raceways.
- N. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.
- O. Tighten set screws of threadless fittings with suitable tool.
- P. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside the box.
- Q. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
- R. Install pull wires in empty raceways. Use no. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

T. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL- 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 at the following points and elsewhere as indicated:

1. Where conduits enter or leave hazardous locations.
2. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
3. Where required by the NEC.

U. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs flush with floor.

### 3.3 ADJUSTING AND CLEANING

A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris.

END OF SECTION 16110

SECTION 16120 - WIRE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes building wires and cables and associated splices, connectors, and terminations for wiring systems rated 600 volts and less.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Division 16 Section "Electrical Identification" for insulation color coding and wire and cable markers.

PART 2 - PRODUCTS

2.1 BUILDING WIRES AND CABLES

- A. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 "Applications" Article.
- B. WC-5 Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- C. WC-7 Cross Linked Thermosetting Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- D. Solid conductor for 16 AWG and smaller; stranded conductor for larger than 16 AWG.

2.2 CONNECTORS AND SPLICES

- A. UL-listed factory-fabricated wiring connectors of size, ampacity rating, material, and type and class for application and for service indicated. Select to comply with Project's installation requirements and as specified in Part 3 "Applications" Article.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine raceways and building finishes to receive wires and cables for compliance with installation tolerances and other conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Feeders: Type THHN/THWN, copper conductor, 90C, 600V insulation in raceway.
- B. Branch Circuits above ground raceways: Type THHN/THWN, copper conductor, 90C, 600V insulation in raceway.
- C. All feeders in under ground conduit: Type XHHW-2, copper conductor, 90C, 600v insulation in raceway.
- D. Branch Circuits in under ground conduit: Type XHHW-2, copper conductor, 90C, 600v insulation in raceway.

### 3.3 INSTALLATION

- A. Install wires and cables as indicated, according to manufacturer's written instructions and the NECA "Standard of Installation."
- B. Pull conductors into raceway simultaneously where more than one is being installed in same raceway.
  - 1. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation.
  - 2. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- C. Conductor Splices: Keep to minimum.
  - 1. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
  - 2. Use splice and tap connectors that are compatible with conductor material.
  - 3. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
  - 4. Use compression connectors for copper conductor splices and taps, 8 AWG and larger. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- D. Wiring at Outlets: Install with at least 12 inches (300 mm) of slack conductor at each outlet. Pigtail wiring to outlet device. Do not use device to continue circuit continuity. Removal of device shall not result in loss of circuit continuity.
- E. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.
- F. Conductor color coding shall be as follows: For 480/277 volts, phase conductors shall be brown, yellow, purple (A,B,C); neutral shall be white with tracer; ground shall be green. For 120/208 volts, phase conductors shall be black, red, blue (A,B,C), neutral shall be white;

ground shall be green.

#### 3.4 INTERFACE WITH OTHER PRODUCTS

- A. Identify wire and cable under provisions of Section 16195.
- B. Identify each conductor with its circuit number or other designation indicated on Drawings.

#### 3.5 FIELD QUALITY CONTROL

- A. Inspect wire and cable for physical damage and proper connection.
- B. Verify tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
- C. Verify continuity of each branch circuit conductor.

END OF SECTION 16120

SECTION 16170 - GROUNDING AND BONDING

PART 1. - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to this Section.
- B. Requirements of the following Division 16 Sections apply to this Section:
  - 1. "Basic Electrical Requirements."

1.2 SUMMARY

- A. This Section includes solid grounding of electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

1.3 QUALITY ASSURANCE

- A. Listing and Labeling: Provide products specified in this Section that are listed and labeled. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.
- B. Electrical Component Standard: Components and installation shall comply with NFPA 70, "National Electrical Code" (NEC).
- C. UL Standard: Comply with UL 467, "Grounding and Bonding Equipment."

PART 2. - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
  - 1. Anixter Bros., Inc.
  - 2. Bashlin Industries, Inc.
  - 3. Buckingham Mfg. Co.
  - 4. A.B. Chance Co.
  - 5. Dossert Corp.
  - 6. Engineered Products Co.
  - 7. Erico Products, Inc.
  - 8. Galvan Industries, Inc.
  - 9. GB Electrical, Inc.
  - 10. General Machine Products Co., Inc.
  - 11. Hastings Fiber Glass Products, Inc.
  - 12. Ideal Industries, Inc.
  - 13. Kearney-National.
  - 14. McGill Mfg.
  - 15. O-Z/Gedney Co.
  - 16. Raco, Inc.
  - 17. Thomas & Betts Corp.

- 18. W.H. Salisbury & Co.
- 19. Utilco Co.

## 2.2 GROUNDING AND BONDING PRODUCTS

- A. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.
- B. Conductor Materials: Copper.

## 2.3 WIRE AND CABLE CONDUCTORS

- A. General: Comply with Division 16 Section "Wires and Cables." Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.
- B. Equipment Grounding Conductor: Green insulated.

## 2.4 MISCELLANEOUS CONDUCTORS

- A. Ground Bus: Bare annealed copper bars of rectangular cross section.
- B. Isolated Ground Bus: Bare annealed copper bars of rectangular cross section. Mount with ground isolation.

## 2.5 CONNECTOR PRODUCTS

- A. General: Listed and labeled as grounding connectors for the materials used.
- B. Bolted Clamps: Heavy-duty units listed for the application.

## PART 3. - EXECUTION

### 3.1 APPLICATION

- A. Equipment Grounding Conductor Application: Comply with NEC Article 250 for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated.

### 3.2 INSTALLATION

- A. General: Ground electrical systems and equipment in accordance with NEC requirements except where the Drawings or Specifications exceed NEC requirements.

### 3.3 CONNECTIONS

- A. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

- B. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.
- C. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.
- D. Compression-Type Connections: Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground conductor.

END OF SECTION 16170

SECTION 16180 - EQUIPMENT WIRING SYSTEMS

1. PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical connections to equipment specified under other sections.

1.2 RELATED SECTIONS

- A. Division 15 - Mechanical
- B. Section 16010 - Basic Electrical Requirements: Owner-furnished equipment.
- C. Section 16110 - Raceways.
- D. Section 16120 - Wire.

1.3 COORDINATION

- A. Coordinate work under provisions of Section 16010.
- B. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.
- C. Determine connection locations and requirements.
- D. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.
- E. Sequence electrical connections to coordinate with start-up schedule for equipment.

2. PART 2 PRODUCTS

2.1 CORDS AND CAPS

- A. Manufacturers:
  - 1. Appleton
  - 2. Hubbell
  - 3. Slater
  - 4. Substitutions: Under provisions of Section 16010.
- B. Attachment Plug Construction: Conform to NEMA.
- C. Configuration: match receptacle configuration at outlet provided for equipment.
- D. Cord Construction: multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
- E. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

3. PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify conditions under provisions of Section 16010.
- B. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.
- D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated.
- E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- F. Install disconnect switches, controllers, control stations, and control devices as indicated.
- G. Modify equipment control wiring with terminal block jumpers as indicated.
- H. Provide interconnecting conduit and wiring between devices and equipment where indicated.

END OF SECTION 16180

SECTION 16190 - SUPPORTING DEVICES

1. PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Conduit and equipment supports.
- B. Anchors and fasteners.

2. PART 2 PRODUCTS

2.1 PRODUCT REQUIREMENTS

- A. Materials and Finishes: Provide adequate corrosion resistance.
- B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.
- C. Anchors and Fasteners:
  - 1. Concrete Structural Elements: Use precast insert system, expansion anchors, powder actuated anchors and preset inserts.
  - 2. Concrete Surfaces: Use self-drilling anchors and expansion anchors.
  - 3. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts and hollow wall fasteners.
  - 4. Solid Masonry Walls: Use expansion anchors and preset inserts.
  - 5. Sheet Metal: Use sheet metal screws.
  - 6. Wood Elements: Use wood screws.

3. PART 3 EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
- C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.
- D. Do not use spring steel clips and clamps.
- E. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- F. Obtain permission from Architect/Engineer before drilling or cutting structural members.
- G. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

- H. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- I. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch (25 mm) off wall.

END OF SECTION 16190

SECTION 16195 - ELECTRICAL IDENTIFICATION

1. PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nameplates and labels.
- B. Wire and cable markers.

2. PART 2 PRODUCTS

2.1 NAMEPLATES AND LABELS

- A. Nameplates: Engraved three-layer laminated plastic, white letters on black background.
- B. Locations:
  - 1. Each electrical distribution and control equipment enclosure.
  - 2. Communication cabinets.
- C. Letter Size:
  - 1. Use 1/4 inch (6 mm) letters for identifying individual equipment and loads.
- D. Labels: Embossed adhesive tape, with 3/16 inch (5 mm) white letters on black background. Use only for identification of individual wall switches and receptacles.

2.2 WIRE MARKERS

- A. Description: Cloth, tape, split sleeve, or tubing type wire markers.
- B. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.
- C. Legend:
  - 1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
  - 2. Control Circuits: Control wire number indicated on schematic and interconnection diagrams on drawings/ shop drawings.

3. PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive nameplates and labels.

3.2 APPLICATION

- A. Install nameplate and label parallel to equipment lines.
- B. Secure nameplate to equipment front using screws, or revets
- C. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

END OF SECTION 16195

SECTION 16425 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to this Section.
- B. Requirements of the following Division 16 Sections apply to this Section:
  - 1. "Basic Electrical Requirements."

1.2 SUMMARY

- A. This Section includes low-voltage power service and distribution switchboards and associated auxiliary equipment rated 600 V or less.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each product and component specified.
- C. Shop drawings for each switchboard including dimensioned plans and elevations, component and device lists, and a single-line diagram showing main and branch bus current ratings and short-time and short-circuit ratings of switchboard.
- D. Shop drawings or other descriptive documentation of optional barriers specified for electrical insulation and isolation.
- E. Shop drawings of utility company metering provisions with indication of approval by utility company.
- F. Schedule of features, characteristics, ratings, and factory settings of individual protective devices.
- G. Qualification data for field-testing organization certificates, signed by the Contractor, certifying that the organization complies with the requirements specified in Quality Assurance below. Include list of completed projects with project names, addresses, names of Architects and Owners, plus other information specified.
- H. Report of field tests and observations certified by the testing organization.
- I. Maintenance data for materials and products, for inclusion in Operating and Maintenance Manual.

1.4 QUALITY ASSURANCE

- A. Listing and Labeling: Provide switchboard assemblies that are listed and labeled.
  - 1. The terms "listed" and "labeled": As defined in the National Electrical Code, Article 100.
  - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- B. Field-Testing Organization Qualifications: To qualify for acceptance, the testing organization must demonstrate, based on evaluation of organization-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated.
- C. Electrical Component Standard: Components and installation shall comply with NFPA 70 with California Amendments, "California Electrical Code."
- D. NEMA Standard: Comply with NEMA Standard PB2, "Deadfront Distribution Switchboards."
- E. UL Standard: Comply with UL 891, "Deadfront Switchboards."
- F. Product Selection for Restricted Space: The Drawings indicate maximum dimensions for switchboard equipment including clearances between switchboard and adjacent surfaces and items. Switchboards having equal performance characteristics and complying with indicated maximum dimensions may be considered.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.
- B. Store so condensation will not occur on or in switchboards. Provide temporary heaters as required to assure avoiding condensation.
- C. Handle switchboards in accordance with NEMA Standard PB2.1, "General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards." Use factory-installed lifting provisions.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cuttler Hammer - Eaton Corp.
2. General Electric Co.
3. Square D Co.

## 2.2 SWITCHBOARDS, GENERAL

- A. Description: Front-connected, front-accessible, with panel-mounted main device, panel-mounted branches, and sections rear aligned.
- B. Barriers: Between adjacent switchboard sections.
1. Insulation and isolation for main and vertical buses of feeder sections.

## 2.3 FABRICATION AND FEATURES

- A. Enclosure: Steel. Outdoor - NEMA 3R, rainproof. Indoor - NEMA 1.
- B. Enclosure Finish for Outdoor Units: UL 891, Paragraph 9.22 C.2, manufacturer's standard color. Undersurfaces shall additionally receive a corrosion-resistant undercoating treatment. The finish system shall meet the requirements of tests in accordance with IEEE C37.20.1, "Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear," paragraph 5.2.8.
- C. Enclosure Finish for Indoor Units: Manufacture standard gray finish over a rust inhibiting primer on phosphatizing treated metal surface. Provide painted surfaces that conform to IEEE C37.20.1, "Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear," paragraph 5.2.8.
- D. Space Heaters: Provide switchboards with factory-installed, electric space heaters in each vertical section.
  1. Space Heater Control: Thermostat, factory-set to maintain switchboard above dewpoint for anticipated environmental conditions.
- E. Utility Metering Compartment: Fabricated compartment and section meeting utility company requirements. Where separate vertical section is required for utility metering, match and align with basic switchboard.
- F. Buses and Connections: Three-phase, four-wire except as otherwise indicated. Features as follows:
  1. Phase and Neutral Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.
  2. Ground Bus: 1/4-inch by 2-inch minimum size, hard-drawn copper of 98 percent conductivity, and equipped with pressure connector terminations for feeder- and branch-circuit ground conductors.
  3. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
  4. Contact Surfaces of Buses: Silver plated.
  5. Main Phase Buses, Neutral Bus, and Equipment Ground Bus: Uniform capacity the entire length of the switchboard main and distribution sections. Provide for future extensions from either end by means of bolt

holes or other approved method and connecting links.

6. Isolation Barrier Access Provisions: Permit checking bus bolt tightness.

7. Neutral Buses: 100 percent of the ampacity of the phase buses except as indicated and equipped with approved pressure connector terminations for outgoing circuit neutral cables. Provide braced neutral bus extensions for busway feeders with neutral conductors.

#### 2.4 OVERCURRENT PROTECTIVE DEVICES (OCPDs)

A. Comply with requirements of Division 16 Section "Overcurrent Protective Devices" for types of OCPDs indicated. Provide indicated features, ratings, characteristics, and settings.

B. Future Devices: Where provision for future overcurrent protective devices or space is indicated, equip compartments with mounting brackets, supports, bus connections, and necessary appurtenances, designed for the OCPD types and ampere ratings indicated for future installation of devices.

#### 2.5 CONTROL POWER

A. General: Where electrically operated devices or ground fault relays requiring external power are indicated, provide 120-V control circuits supplied through secondary disconnect devices from control power transformer.

B. Control Wiring: Factory-installed, complete with bundling, lacing, and protection. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

#### 2.6 RATINGS

A. Provide nominal system voltage, continuous main bus amperage, and short-circuit-current ratings as indicated.

B. Nominal System Voltage: 480/277 V, 60 Hz.

C. Main Bus Continuous: 400 amperes copper bus density 1000amps per sqin.

#### 2.7 IDENTIFICATION

A. General: Refer to Division 16 Section "Electrical Identification." Identify units, devices, controls, and wiring with factory-applied labels and signs.

B. Compartment Nameplates: Engraved laminated plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws.

### PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General: Install switchboards and accessory items in accordance with manufacturers' written installation instructions and the following specifications:
- B. Strength, Spacing, and Placement of Equipment Housekeeping Pads: Where a membrane-waterproofed floor or pressure slab is indicated under the switchboard, and where otherwise indicated, provide a concrete housekeeping pad. Fabricate pads as follows:
  - 1. Coordinate size of equipment bases with actual unit sizes provided. Fabricate base 4 inches larger in both directions than the overall dimensions of the supported unit, unless otherwise noted.
  - 2. Footings: For outdoor switchboard pads, provide footings as indicated.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

### 3.2 GROUNDING

- A. Connections: As indicated. Tighten connections to comply with tightening torques specified in UL 486A and 486B.
- B. Ground equipment to main electrical ground bus indicated. Provide minimum 5-ohm ground resistance at switchboard location.

### 3.3 CONNECTIONS

- A. Tighten switchboard bus joint bolts and electrical connector and terminal bolts in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values are not stated, use those specified in UL 486A and UL 486B.

### 3.4 FIELD QUALITY CONTROL

- A. General: Comply with applicable standards of the InterNational Electrical Testing Association (INETA) including Standard ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems."
- B. Independent Testing Organization: Arrange and pay for the services of an independent electrical testing organization to perform quality control electrical testing and calibration, visual and mechanical inspections, and tests of overcurrent protective devices switchboards.
- C. Pretesting: Upon completing installation of the system, perform the following preparations for tests:
  - 1. Make insulation resistance tests of switchboard buses, components, and connecting supply, feeder, and control circuits.

2. Make continuity tests of circuits.
  3. Provide set of Contract Documents to test organization. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.
  4. Provide manufacturer's instructions for installation and testing of switchboard to test organization.
- D. Quality Control Testing Program: Conform to the following:
1. Program Objectives: To assure switchboard installation meets specified requirements, is operational within specified tolerances, provides appropriate protection for systems and equipment, and is suitable for energizing.
  2. Procedures: Make field tests and inspections and prepare switchboard for satisfactory operation in accordance with manufacturer's recommendations and these specifications.
  3. Schedule tests and notify Engineer at least one week in advance of test commencement.
  4. Reports: Prepare written reports of test results and observations. Report defective materials and workmanship. Include complete records of adjustments and remedial efforts.
  5. Labeling: Upon satisfactory completion of tests and related effort. Apply a label to tested components indicating test results, person responsible, and date.
  6. Protective Device Ratings and Settings: Verify indicated ratings and settings and make the final system adjustments of OCPDs in accordance with Division 16 Section "Overcurrent Protection Devices."
- E. Visual and Mechanical Inspections: Include the following inspections and related work:
1. Inspect for defects and physical damage, testing laboratory, labels, and nameplate compliance with up-to-date circuit connections.
  2. Verify that potential transformers, including their overcurrent protection and current transformers, meet specified requirements.
  3. Perform operational test and exercise of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
  4. Check switchboard anchorage, area clearances, and alignment and fit of components.
  5. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
  6. Clean switchboard interior and exterior using manufacturer's approved methods and materials.
  7. Perform visual and mechanical inspection and related work for OCPDs as specified in Section "Overcurrent Protective Devices."
- F. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:
1. Insulation resistance test of buses and portions of control wiring that disconnect from solid state devices through normal disconnecting features. Insulation resistance less than 100 megohms is not acceptable.
  2. Ground resistance test on system and equipment ground connections.
  3. Test overcurrent protective devices as specified in Section "Overcurrent Protective Devices."

- G. Retesting: Correct deficiencies identified by tests and observations and retest switchboards. Verify by the retests that switchboards meet specified requirements.

### 3.5 CLEANING

- A. Upon completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

### 3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat in accordance with manufacturer's recommendation within each section of switchboards throughout periods during which the switchboard is not in a space that is continuously under normal control of temperature and humidity.

END OF SECTION 16425

SECTION 16475 - OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to this Section.
- B. Requirements of the following Division 16 sections apply to this Section:
  - 1. "Basic Electrical Requirements."

1.2 SUMMARY

- A. This Section includes overcurrent protective devices (OCPDs) rated 600 V and below and switching devices commonly used with them.
- B. Panelboards, Switchboards, and Motor Control Centers: Application, installation, and other related requirements for overcurrent protective device installations in distribution equipment are specified in other Division 16 sections.

1.3 DEFINITIONS

- A. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.
- B. Ampere-Squared-Seconds: An expression of available thermal energy resulting from current flow. With regard to current-limiting fuses and circuit breakers, the ampere-squared-seconds during fault current interruption represents the energy allowed to flow before the fuse or breaker interrupts the fault current within its current limiting range.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for fuses, fusible switches, circuit breakers, and OCPD accessories specified in this Section, including descriptive data and time-current curves for all protective devices and let-through current curves for those with current limiting characteristics. Include coordination charts and tables and related data.

1.5 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 with California Amendments "California Electrical Code."
- B. Listing and Labeling: Provide products specified in this Section that are

listed and labeled.

1. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- C. Single-Source Responsibility: Obtain similar OCPDs from a single manufacturer.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
  1. Molded-Case Circuit Breakers:
    - a. Cuttler Hammer - Eaton Corp.
    - b. General Electric Co.
    - c. Square D Co.
  2. Combination Circuit Breaker and Ground Fault Circuit Interrupters:
    - a. Cuttler Hammer - Eaton Corp.
    - b. General Electric Co.
    - c. Square D Co.

### 2.2 OVERCURRENT PROTECTIVE DEVICES (OCPDs), GENERAL

- A. General: Provide OCPDs in indicated types, as integral components of panelboards and switchboards also as individually enclosed and mounted single units.

### 2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. General: UL 489, "Molded Case Circuit Breakers and Circuit Breaker Enclosures," and NEMA AB 1, "Molded Case Circuit Breakers."
- B. Construction: Bolt-in type, except breakers in load-center-type panelboards and breakers 225-ampere frame size and larger may be plug-in type if held in place by positive locking device requiring mechanical release for removal.
- C. Characteristics: Indicated frame size, trip rating, number of poles, and a short-circuit interrupting capacity rating of 10,000 amperes symmetrical, unless a greater rating is indicated.
- D. Tripping Device: Quick-make, quick-break toggle mechanism with

inverse-time delay and instantaneous overcurrent trip protection for each pole.

- E. Adjustable Instantaneous Trip Devices: Factory adjusted to low-trip-setting current values.
- F. Suitable for panel mounting in switchboard or panelboards where indicated.
- G. Combination Circuit Breakers and Ground Fault Circuit Interrupters: UL 943 "Ground Fault Circuit Interrupters," arranged for sensing and tripping for ground fault current in addition to overcurrent and short-circuit current. Provide features as follows:
  - 1. Match features and module size of panelboard breakers and provide clear identification of ground fault trip function.
  - 2. Trip setting for ground fault lowest possible unless otherwise directed by Engineer. Check with Engineer prior to performing Independent Testing of equipment.
- H. Circuit Breakers With Solid-State Trip Devices: Provide indicated circuit breakers with solid-state trip devices having the following features:
  - 1. Ambient Compensation: Trip device insensitive to temperature changes between minus 20 deg C and plus 55 deg C.
  - 2. Adjustability: Breaker ratings and trip settings shall be changeable by operation of controls on front panel of breaker, by change of plug-in element without removing breaker from mounting, or by a combination of the two methods.
  - 3. Ground-Fault Tripping: Adjustable for pick-up and time-delay values. Provide for indicated units.

#### 2.7 INSULATED-CASE CIRCUIT BREAKERS

- A. General: UL 489, "Molded-Case Circuit Breakers and Circuit Breaker Enclosures," and NEMA AB 1, "Molded-Case Circuit Breakers."
- B. Ratings: Continuous-current, interrupting, and short-time-current ratings, and voltage and frequency ratings as indicated.
- C. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
  - 1. Moving Contacts Closing Speed: Independent of both control and operator.
  - 2. Stored-Energy Mechanism: Manually charged.
  - 3. Stored-Energy Mechanism: Electrically charged, with provision for optional manual charging.
  - 4. Operation Counter: Include except as otherwise indicated.
- D. Circuit-Breaker Trip Devices: Solid-state overcurrent trip device system that includes one integrally mounted current transformer or sensor per phase, a release mechanism, and the following features:
  - 1. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, which are independent of each other in both action and

adjustment.

2. Temperature compensation to assure accuracy and calibration stability from minus 20 deg C to plus 55 deg C.
  3. Field-adjustable, time-current characteristics.
  4. Current Adjustability: Effected by operating controls on front panel or by changing plug-in elements or current transformers or sensors.
  5. Three bands for long-time- and short-time-delay functions marked "minimum," "intermediate," and "maximum."
  6. Five pickup points, minimum, for long-time- and short-time-trip functions.
  7. Six pickup points, minimum, for instantaneous-trip functions.
  8. Ground fault protection with at least three short-time-delay settings and three trip-time-delay bands. Adjustable current pickup.
  9. Trip Indication: Labeled lights or mechanical indicators on trip device shall indicate type of fault causing breaker trip. If lights are used, integral power source shall maintain indication for 60 hours, minimum.
- E. Circuit-Breaker Features and Accessories: Include the following:
1. Padlocking Provisions: For installing at least three padlocks on each breaker to secure its enclosure.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Independently Mounted OCPDs: Locate as indicated and install in accordance with manufacturer's written installation instructions.
- B. OCPDs in distribution equipment shall be factory installed.

#### 3.2 IDENTIFICATION

- A. Identify components in accordance with Division 16 Section "Electrical Identification."

#### 3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between OCPDs and control/indication devices as specified in Division 16 Section "Wires and Cables" for hard wired connections.

#### 3.4 CONNECTIONS

- A. Check connectors, terminals, bus joints, and mountings for tightness. Tighten field-connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

### 3.5 GROUNDING

- A. Provide equipment grounding connections for individually mounted OCPD units as indicated and as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

### 3.6 FIELD QUALITY CONTROL

- A. Independent Testing Organization: Arrange and pay for the services of an independent electrical testing organization to perform tests and observations on OCPDs.
- B. Reports: Prepare written reports certified by testing organization on tests and observations. Report defective materials and workmanship and unsatisfactory test results. Include complete records of repairs and adjustments made.
- C. Labeling: Upon satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.
- D. Schedule visual and mechanical inspections and electrical tests with at least one week's advance notification.
- E. Pretesting: Upon completing installation of the system, perform the following preparations for independent tests:
  1. Make insulation resistance tests of OCPD buses, components, and connecting supply, feeder, and control circuits.
  2. Make continuity tests of circuits.
  3. Provide set of Contract Documents to test personnel. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.
  4. Provide manufacturer's instructions for installation and testing of OCPDs to test personnel.
- F. Visual and mechanical inspection: Include the following inspections and related work.
  1. Overcurrent-Protective-Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system arrangement and parameters. Where discrepancies are found, test organization shall recommend final protective device ratings and settings. Use accepted revised ratings or settings to make the final system adjustments.
  2. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current single line diagram.
  3. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
  4. Check tightness of electrical connections of OCPDs with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
  5. Clean OCPDs using manufacturer's approved methods and materials.
  6. Verify installation of proper fuse types and ratings in fusible OCPDs.

- G. Electrical Tests: Include the following items performed in accordance with manufacturer's instructions:
1. Insulation resistance test of OCPD conducting parts. Insulation resistance less than 100 megohms is not acceptable.
  2. Contact resistance test or measurement of millivolt drop across contacts of drawout circuit breakers and fused power circuit devices at rated current. Compare contact resistance or millivolt drop values of adjacent poles and of similar breakers. Deviations of more than 50 percent are not acceptable.
  3. Insulation resistance test of fused power circuit devices and insulated-case and molded-case circuit breakers over 600-ampere frame size at 1000 V d.c. for one minute from pole to pole and from each pole to ground with breaker closed and across open contacts of each phase. Insulation resistance less than 100 megohms is not acceptable.
  4. Use primary current injection to check performance characteristics of trip units of insulated-case circuit breakers and molded-case breakers over 600-ampere frame size. Trip characteristics not falling within manufacturer's published time-current characteristic tolerance bands when adjusted to approved parameters are not acceptable. Perform the following tests:
    - a. Determine minimum pickup current acceptable per manufacturer's instructions.
    - b. Determine long-time delay at 300 percent pickup current.
    - c. Determine short-time-pickup current and corresponding delay time.
    - d. Determine ground-fault current pickup and corresponding delay time.
    - e. Determine instantaneous pickup current value.
  5. Verify trip unit reset characteristics for insulated-case circuit breakers.
  6. Make adjustments for final settings of adjustable-trip devices.
  7. Activate auxiliary protective devices such as ground fault or undervoltage relays, to verify operation of shunt-trip devices.
  8. Check stored-energy charging motors for proper operation of motor, mechanism, and limit switches.
  9. Check operation of electrically operated OCPDs in accordance with manufacturer's instructions.
- H. Retest: Correct deficiencies identified by tests and observations and provide retesting of OCPDs by testing organization. Verify by the system tests that specified requirements are met.

### 3.7 CLEANING

- A. Upon completion of installation, inspect OCPDs. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

END OF SECTION 16475