

**READ THIS FIRST**

Notice to the Design Engineer, this document is part of Facilities and Infrastructure standards for Electrical Systems. Designers are advised to NOT use this template (\*.doc) document as part of any project contract documents. Designers shall use the Port of Seattle MasterSpec specifications from the following link:

**<https://www.portseattle.org/page/guide-specifications>.**

Designers shall edit the corresponding Port's MasterSpec specification to meet the F&I Electrical Standard outlined in this specification. Note that Port's MasterSpec specifications contain specifications and languages for both Aviation and Maritime Divisions. F&I Standards are strictly for Aviation Division, and any Maritime related specs or languages should be removed from the project specifications.

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY AND NOTES TO DESIGNER**

- A. Section Includes:
  - 1. Service and distribution switchboards rated 600 V and less.
  - 2. Transient voltage suppression devices.
  - 3. Disconnecting and overcurrent protective devices.
  - 4. Instrumentation.
  - 5. Control power.
  - 6. Accessory components and features.
  - 7. Identification.
- B. All switchboards shall be labeled with Arc Flash Hazard level, as calculated by engineer of record. Label shall include the following information: Date of study, Engineer of Record, Arc Flash Level and Port of Seattle Representative initial. Label shall be provided by engineer of record and installed by POS F&I. Refer to Section 260573 – Power Systems Studies.
- C. Short circuit ratings: When specifying AIC ratings, give consideration to the possibility that available fault current may increase in the future due to increase in utility transformer size.
- D. When calculated available fault current is within 15% of standard switchboard AIC rating, switchboard shall be specified with the next higher AIC rating.
  - 1. Example: if panelboard comes in standard ratings of 42kAIC and 65kAIC, and calculated AIC is 35.7kA or greater, panel shall be specified with 65kAIC rating.

- E. Coordinate trip curves so that faults and shorts will clear at the nearest overcurrent device without tripping upstream devices. Normal Power electrical systems should be coordinated to 0.1sec range. Emergency power systems shall be coordinated to comply with NEC requirements.
- F. Access: Typically switchboards do not require side and rear access unless required by project parameters or engineering considerations.
- G. Main circuit breakers are preferred over fused switches for switchboard mains through 1200A, and are to be individually mounted in compartments to isolate them from group mounted feeder breakers. This applies to both single main and multiple main (6 max) configurations.
- H. Fused bolted pressure switches may be used for mains 1200A and above where required for interrupting capacity, current limiting, or coordination.
- I. Fused switches may be applied up to, but not including, 1200A rating where required for interrupting capacity and/or current limiting.
- J. Feeder breakers rated 800A and less shall be group mounted. Feeder breakers rated for greater than 800 amps shall be mounted in individual compartments.
- K. Molded-Case Circuit Breaker (MCCB): May be applied up to, but not including, 1200A frame size. Comply with UL 489, with interrupting capacity to meet available fault currents.
  - 1. Trip settings shall be provided in contract documents by engineer of record, for long time pick up, short time pick up, instantaneous, ground fault and over- and under-voltage trip.

### **1.3 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Include evidence of NRTL listing for series rating of installed devices.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
9. Include schematic and wiring diagrams for power, signal, and control wiring.

### **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Seismic Controls for Electrical and Communication Work." Include the following:
  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. Field Quality-Control Reports:
  1. Test procedures used.
  2. Test results that comply with requirements.
  3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

### **1.6 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  1. Routine maintenance requirements for switchboards and all installed components.
  2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
4. Provide as-built panel schedules in Port standard excel format. Provide excel files electronically to F&I upon project completion.

### **1.7 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish standby materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Standby Fuses: Furnish one spare for every five installed units, but no fewer than one set of three of each type.
  2. Standby Indicating Lights: Furnish one spare for every five installed units, but no less than one set of three of each type.
  3. Touch-up Paint: One pint container of paint matching enclosure finish packaged with protective covering for storage and identified with labels.

### **1.8 QUALITY ASSURANCE**

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
  1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. 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.
- F. Comply with NEMA PB 2.
- G. Comply with NFPA 70.
- H. Comply with UL 891.

**1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation where necessary.
- C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

**1.10 PROJECT CONDITIONS**

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
  - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding 104 deg F.
    - b. Altitude: Not exceeding 1000 feet.

**1.11 COORDINATION**

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

**1.12 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

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**PART 2 - PRODUCTS**

**2.1 MANUFACTURED UNITS**

- A. Comply with:
1. NEMA PB2, UL 891.
  2. NEC requirements of Authority Having Jurisdiction.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. EATON
  2. General Electric Company; (only if rated for 40°C ambient operation.)
  3. Square D.
- C. All material shall be of the same manufacturer.
- D. Front-Connected, Front-Accessible Switchboards:
1. Main Devices: Panel mounted.
  2. Branch Devices: Panel mounted.
  3. Sections front and rear aligned.
- E. Nominal System Voltage: 480Y/277 V OR 208Y/120 V.
- F. Main-Bus Continuous: Maximum 2000A. See Section 262300 "Low Voltage Switchgear" for distribution equipment larger than 2000A.
- G. Provide equipment with sufficient fault duty for available fault currents.
- H. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Seismic Controls for Electrical and communication Work."
- I. Indoor Enclosures: Steel, NEMA 250, Type 1.
- J. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- K. Outdoor Enclosures: Type NEMA 3R or 4X.
1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
  2. Enclosure: Downward, rearward sloping roof; bolt-on rear covers for each section, with provisions for padlocking. Front door to be provided with inner gasket to prevent water egress.
  3. Walk-in Aisle Heating and Ventilating:
    - a. Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard

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- interior temperature of 40 deg F with outside design temperature of 104 deg F.
  - b. Ventilating openings.
  - c. Thermostat: Single stage; wired to control heat.
  - 4. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include a control-power transformer within the switchboard. Supply voltage shall be 120V ac.
  
  - L. Extend front of switchboard enclosure to include a door for switchboard located outside dedicated electrical room. Door shall be lockable and shall shield breakers from operation by unauthorized personnel.
  
  - M. Barriers: Between adjacent switchboard sections.
  
  - N. Cubical Space Heaters for Outdoor Mounted Gear: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
    - 1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point. Provide manual disconnect.
    - 2. Space-Heater Power Source: Transformer, factory installed in switchboard.
  
  - O. Customer Metering Compartment: Where required, provide a separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Coordinate metering requirements with F&I.
  
  - P. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
  
  - Q. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
  
  - R. Buses and Connections: Three phase, four wire unless otherwise indicated.
    - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated, with tin-plated aluminum or copper feeder circuit-breaker line connections. ALUMINUM BUS WILL NOT BE ALLOWED.
    - 2. Ground Bus: 1/4-by-2-inch hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
    - 3. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
    - 4. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
  
  - S. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

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## 2.2 TRANSIENT VOLTAGE SUPPRESSION DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. EATON Innovative Technology
  2. Thomas and Betts/Current Technology
  3. Square D.
  4. Morris Tech
- B. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, wired-in solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:
1. Fabrication using bolted compression lugs for internal wiring.
  2. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
  3. LED indicator lights for power and protection status.
  4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
- C. Peak Single-Impulse Surge Current Rating: 80 kA per mode/160 kA per phase.
- D. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
- E. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 OR 208Y/120 -V, three-phase, four-wire circuits shall be as follows:
1. Line to Neutral: 800 V for 480Y/277 OR 400 V for 208Y/120.
  2. Line to Ground: 800 V for 480Y/277 OR 400 V for 208Y/120.
  3. Neutral to Ground: 800 V for 480Y/277 OR 400 V for 208Y/120
- F. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:
1. Line to Neutral: 400 V, 800 V from high leg.
  2. Line to Ground: 400 V.
  3. Neutral to Ground: 400 V.
- G. Protection modes and UL 1449 SVR for 240-, 480-, or 600-V, three-phase, three-wire, delta circuits shall be as follows:
1. Line to Line: 2000 V for 480 V OR 1000 V for 240 V.
  2. Line to Ground: 1500 V for 480 V OR 800 V for 240 V.

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### 2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): May be applied up to, but not including, 1200A frame size. Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 225 A and larger. Main and branch circuit breaker above 225A to be 100% rated.
  2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
    - a. Instantaneous trip.
    - b. Long- and short-time time adjustments.
    - c. Ground-fault pickup level, time delay, and  $I^2t$  response.
  4. Current-Limiting Circuit Breakers: Frame sizes 400 A and larger; let-through ratings less than NEMA FU 1, RK-5.
  5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
  6. GFCI Circuit Breakers, where required: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
  7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers, where required: Class B ground-fault protection (30-mA trip).
  8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    - a. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material. Only Copper Lugs are allowed.
    - b. Ground-Fault Protection: Integrally mounted or remote-mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator. Settings as indicated in contract drawings.
    - c. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
    - d. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay, as required by contract drawings.
    - e. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts. Provide for conveyor motor loads, switchboard mains and as required by contract drawings.
- B. Insulated-Case Circuit Breaker (ICCB): For 1200A frame sizes and above. 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
1. Fixed circuit-breaker mounting.
  2. Two-step, stored-energy closing.
  3. Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
    - a. Instantaneous trip.
    - b. Long- and short-time time adjustments.

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- c. Ground-fault pickup level, time delay, and I<sup>2</sup>t response.
  4. Remote trip indication and control.
  5. Communication Capability: See Section 262713 "Electrical Power Metering."
  6. Control Voltage: 120V ac.
- C. Bolted-Pressure Contact Switch: For 1200A frame sizes and above. Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.
1. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.
  2. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
    - a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
    - b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.
  3. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
  4. Service-Rated Switches: Labeled for use as service equipment.
  5. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.
    - a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    - b. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
    - c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
    - d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).
  6. Open-Fuse Trip Indicating Device: Arranged to trip switch open if a phase fuse opens, mounted on panel.
- D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- E. Fuses are specified in Section 262813 "Fuses."

## 2.4 INSTRUMENTATION

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
1. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, **[single]** **[tapped]** **[double]** secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
  2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; **[single]** **[double]** secondary winding and secondary shorting device. Burden and accuracy

- shall be consistent with connected metering and relay devices. Compatible with EATON PQM and PEM series meters.
3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
  4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems. EATON PQM and PEM series, with the following features:
1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    - a. Phase Currents, Each Phase: Plus or minus 1 percent.
    - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
    - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
    - d. Kilowatts: Plus or minus 2 percent.
    - e. Kilovars: Plus or minus 2 percent.
    - f. Power Factor: Plus or minus 2 percent.
    - g. Frequency: Plus or minus 0.5 percent.
    - h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours. Revenue grade accuracy per WAC and RWC.
    - i. Communication protocol: Modbus, TCP/IP, Ethernet compatible.
  2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

## **2.5 CONTROL POWER**

- A. Control Circuits: 120V ac, supplied through secondary disconnecting devices from control-power transformer.
- B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible SIS conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

## **2.6 ACCESSORY COMPONENTS AND FEATURES**

- A. Provisions for Expansion: Make provisions for adding future sections.
- B. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

**2.7 IDENTIFICATION**

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.
- B. Comply with labeling requirements in Section 250553 "Identification for Electrical Systems".

**PART 3 - INSTALLATION**

**3.1 EXAMINATION**

- A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 SWITCHBOARD INSTALLATION**

- A. Install switchboards and accessories according to NEMA PB 2.1
- B. Provide dedicated electrical space for switchboards per NEC 110-26.
- C. Comply with NEC 408 for general requirements for switchboards.
- D. Equipment Mounting: Install switchboards on concrete base, 3-1/2 inch nominal thickness Concrete shall be rated 3000 psi minimum.
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
  - 5. Concrete bases shall be leveled to no more than 0.25 inches of deviation for every 3 feet in ALL directions.
  - 6. Contractor shall notify F&I and AV Maintenance prior to concrete pour to measure concrete base and assess base's levelness.
  - 7. Concrete bases shall have smooth finishes. Broom finishes are prohibited.

- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- F. Comply with mounting and anchoring requirements specified in Section 260548 "Seismic Controls for Electrical and Communication Work."
- G. Provide yellow striping in front of all switchboards outlining required code required working space.
- H. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- I. Install filler plates in unused spaces of panel-mounted sections.
- J. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
  - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- K. Torque all lugs per manufacturer's recommendations. When manufacturer's recommendations are unavailable, use UL 486A and UL 486B for torque values. Place spot of red pain on lugs after torqueing such that paint will be visibly disturbed if lugs are disturbed.
- L. Install spare-fuse cabinet.
- M. Comply with NECA 1.

### **3.3 CONNECTIONS**

- A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.
- B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

### **3.4 IDENTIFICATION**

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### **3.5 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Megger test switchboard and feeders with all breakers open before energizing. Use 1000V Megger for 480V equipment and 500V megger for 208V equipment.
  - 4. Check phase rotation of all conductors and ensure proper color coding.
  - 5. Verify continuity and tightness of ground connections.
  - 6. Ensure viability of bonding jumper when switchboards are used as service entrances.
  - 7. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
    - c. Instruments and Equipment:
      - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Switchboard will be considered defective if it does not pass tests and inspections.
- E. After energization, check load balance under normal operation. If load unbalance exceeds 10%, initiate corrective measures.

- F. Prepare tests and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

**3.6 ADJUSTING**

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated or as specified in Section 260573 "Power System Studies."

**3.7 PROTECTION**

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

**3.8 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units. Provide training session to three maintenance shifts, with minimum 10 persons per training session.

END OF SECTION 262413