

**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. This Section includes metal-enclosed, low-voltage, draw-out, power circuit-breaker switchgear, 1600 Amps to 5,000 Amps, 600 Volts maximum rating used as main service equipment in primary facilities (e.g., generally those facilities intrinsic to 24 hour per day airport operations).
- B. Consider the possibility of future increases in available fault currents due to upsizing of utility transformers. Specify switchgear with adequate AIC rating to accommodate some future increase in available fault current.
- C. Size switchgear to allow for minimum 30% spare capacity and 30% spare breaker capacity.
- D. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks where required by project parameters.
  - 1. For double ended switchgear, the typical configuration is main-tie-main with mechanical interlock of mains and tie.
- E. Related Sections include the following:
  - 1. Section 261116.11 - Secondary Unit Substations Switchgear.
  - 2. Section 260913 - Electrical Power Monitoring for interfacing communication and metering requirements.

### **1.3**     **DEFINITIONS**

- A.    ATS: Acceptance Testing Service.
- B.    GFCI: Ground-fault circuit interrupter.

### **1.4**     **ACTION SUBMITTALS**

- A.    Product Data: For each type of switchgear, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B.    Shop Drawings: For each type of switchgear and related equipment.
  - 1.    Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:
    - a.    Tabulation of installed devices with features and ratings.
    - b.    Enclosure types and details.
    - c.    Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
    - d.    Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
    - e.    Current rating of buses.
    - f.    Short-time and short-circuit current rating of switchgear assembly.
    - g.    Nameplate legends.
    - h.    Mimic-bus diagram.
    - i.    Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 2.    Wiring Diagrams: Power, signal, and control wiring.

### **1.5**     **INFORMATIONAL SUBMITTALS**

- A.    Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- B.    Manufacturer Seismic Qualification Certification: Submit certification that switchgear, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems." Include the following:
  - 1.    Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a.    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."

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. Qualification Data: For testing agency.
- D. Field quality-control test reports.
- E. Updated mimic-bus diagram reflecting field changes after final switchgear load connections have been made, for record.

#### **1.6 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For switchgear 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. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

#### **1.7 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish standby extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: Six of each type and rating used. Include spares for potential transformer fuses, control power fuses, and fuses and fusible devices for fused circuit breakers.
  2. Indicating Lights: Six of each type installed.
  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. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain switchgear through one source from a single manufacturer.

- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated. Refer to Section 016000 "Product Requirements."
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NFPA 70.

## **1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver switchgear in sections of lengths that can be moved past obstructions in delivery path.
  - 1. Provide shipping splits to facilitate adequate clearances for moving equipment into building with minimum disruption to existing building and systems.
- B. Shipments shall be made with impact recording devices set (accelerometers) at 0.3g or as approved by F&I.
- C. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation, and per manufacturer's recommendations. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- D. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250W per section) to prevent condensation.

## **1.10 PROJECT CONDITIONS**

- A. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
  - 1. Ambient Temperature: Not exceeding 40 deg C.
  - 2. Altitude: Not exceeding 1000.

**1.11 COORDINATION**

- A. Coordinate layout and installation of switchgear and components with other construction that penetrates ceilings or is supported by them, including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.
  - 1. Ensure that pipes and ducts do not pass over the switchgear, through working space, or draw-out space.
- B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

**1.12 SOURCE QUALITY CONTROL**

- A. Make completed switchgear available for inspection at manufacturer's factory prior to packaging for shipment. Notify the Port at least two weeks before inspection is allowed.
- B. Allow witnessing of factory inspections and tests at manufacturer's factory or test facility. Notify the Port at least two weeks before inspections and tests are scheduled.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. EATON
  - 2. Square D
  - 3. General Electric Company. (Verify equipment is rated for operation at 40°C ambient)
- B. All equipment shall be new and of the same manufacturer.

**2.2 RATINGS**

- A. Nominal System Voltage: 480/277 V, 3Ø, 4 wire, OR 208/120 V, 3Ø, 4 wire, 60 Hz.
- B. Main-Bus Continuous: As indicated on drawings. Minimum 1600 A.
- C. Short-Time and Short-Circuit Current: Nameplate fault duty for breakers and busway shall exceed the available current at the point of connection. Provide documentation to substantiate compliance.
  - 1. No series rated equipment allowed.

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**2.3 FABRICATION**

- A. Factory assembled and tested and complying with IEEE C37.20.1.
- B. Indoor Enclosure Material: Steel, NEMA 1.
- C. Outdoor Enclosure Material: Galvanized steel, NEMA 3R.
- D. Outdoor Enclosure Fabrication Requirements: Weatherproof; walk-in, integral structural-steel base frame with factory-applied asphaltic undercoating; and each compartment equipped with the following features:
  - 1. Structural design and anchorage adequate to resist loads imposed by 125-mph wind.
  - 2. Steel floor with anti-skid treatment.
  - 3. Space heater, thermostatically controlled, operating at one-half or less of rated voltage, sized to prevent condensation within switchgear. Provide power source within switchgear with code required overload protection.
  - 4. Common internal aisle of sufficient width to permit protective-device withdrawal, disassembly, and servicing in aisle, 42 inches minimum.
  - 5. Two aisle access doors with outside padlocking provisions and interior panic hardware which cannot be defeated by latches or padlocks.
  - 6. Aisle space heaters operating at one-half or less of rated voltage, thermostatically controlled.
  - 7. Interior lighting: High output fluorescent fixtures with wet label, with lenses and wireguards. Provide switches at both entrances. Light level minimum 70 footcandles normal and 40 footcandles emergency.
  - 8. Two GFCI 120V duplex receptacles connected to 15 ampere source.
  - 9. Aisle ventilation louvers equipped with insect and rodent screen and filter and arranged to permit air circulation while excluding insects, rodents, and exterior dust.
  - 10. Roof sloping towards the rear.
  - 11. Undercoating of all areas in contact with foundation.
- E. Access: Front and rear access is required. Side access may be required and should be considered in determining space allowances.
- F. Circuit Breaker Compartments:
  - 1. Equipped to house draw-out type circuit breakers and shall be fitted with hinged outer doors.
  - 2. Sufficient conduit and (or) busway entrance space must be provide in each section so that horizontal wiring within the switchgear is not required.
  - 3. Full height metal barriers are required between adjacent vertical structures in the rear access cable compartment.
- G. Busbars: Fully insulated copper.
- H. Ground Bus: Provide a full width copper ground bus.
- I. Lugs: Provide lugs for incoming service cables or hardware for incoming service bus.

- J. Finish: IEEE C37.20.1, manufacturer's standard ANSI 61 gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.
- K. Bus isolation barriers shall be arranged to isolate circuit breaker compartment from main bus compartment.
- L. Fabricate enclosure with removable, hinged, rear cover panels to allow access to rear interior of switchgear.
- M. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:
  - 1. Bus transition sections.
  - 2. Incoming-line pull sections.
  - 3. Hinged front panels for access to metering, accessory, and blank compartments.
- N. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.
  - 1. Main Phase Bus: Uniform capacity the entire length of assembly.
  - 2. Neutral Bus: 100 percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
  - 3. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
  - 4. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
  - 5. Use copper for connecting circuit-breaker line to copper bus.
  - 6. Contact Surfaces of Buses: Silver plated.
  - 7. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
  - 8. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 1/4 by 2 inches.
  - 9. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
  - 10. Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
  - 11. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.

## **2.4 COMPONENTS**

- A. Instrument Transformers: Comply with IEEE C57.13. Provide devices compatible with EATON PQM series meters.
  - 1. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
  - 2. Current Transformers: Ratios as indicated; burden and accuracy class suitable for connected relays, meters, and instruments.

- B. Multifunction Digital-Metering Monitor: UL-listed or -recognized, microprocessor-based unit suitable for three- or four-wire systems, revenue grade in compliance with WAS and RCW requirements. EATON PQM, PEM series. See Section 262713 - Electrical Power Metering.
  - 1. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
- C. Relays: Where required, comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.
- D. Surge Arresters: Distribution class, metal-oxide-varistor type. Comply with IEEE C62.11 and NEMA LA 1.
  - 1. Install in cable termination compartments and connect in each phase of circuit.
  - 2. Coordinate rating with circuit voltage.
- E. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.
  - 1. Allow floor space for addition of future vertical sections.
- F. Control Power Supply: Control power transformer supplying 120V control circuits through secondary disconnect devices. Include the following features:
  - 1. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
  - 2. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.
    - a. Secondary windings connected through a relay or relays to control bus to effect an automatic transfer scheme.
  - 3. Control Power Fuses: Primary and secondary fuses with current-limiting and overload protection.
  - 4. Fuses are specified in Section 262813 "Fuses."
- G. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
  - 1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
  - 2. Conductors sized according to NFPA 70 for duty required.

## **2.5 CIRCUIT BREAKERS**

- A. Description: Comply with IEEE C37.13.
- B. All circuit breakers shall be draw-out, low voltage power air circuit breakers.



- C. Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.
- D. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
  - 1. Normal Closing Speed: Independent of both control and operator.
  - 2. Slow Closing Speed: Optional with operator for inspection and adjustment.
  - 3. Stored-Energy Mechanism: Electrically charged.
- E. Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:
  - 1. For main circuit breakers, provide electronic trip units with programmable curve shaping, ground fault, power and energy monitoring, harmonic monitoring and analysis, event capture and communications capability to Port's monitoring and control system.
  - 2. For feeder breakers, provide electronic trip units with manual curve shaping, ground fault and energy monitoring and communications capability to Port's monitoring and control system.
  - 3. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
  - 4. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
  - 5. Field-adjustable, time-current characteristics.
  - 6. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
  - 7. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
  - 8. Pickup Points:
    - a. Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I<sup>2</sup>t operation.
    - b. Pickup Points: Five minimum, for instantaneous-trip functions.
  - 9. Ground-fault protection where required by code or design shall be capable of at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:
    - a. Four-wire circuit or system.
  - 10. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault. Trip indicators shall use non-volatile memory.
- F. Arc Flash Reduction Maintenance By-Pass: Allows breaker trip setting to be manually set to instantaneous for temporary reduction of arc flash hazard level. Indicator light on face of breaker indicates that breaker is in by-pass mode.
- G. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing. Provide as indicated on drawings.

- H. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:
1. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
  2. Circuit-Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open. Status for connection devices for different positions includes the following:
    - a. Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
    - b. Disconnected Position: Primary and secondary devices and ground contact disengaged.
- I. Padlocking Provisions: For installing 3/8 inch hasp padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.
- J. Operating Handle: One for each circuit breaker capable of manual operation.
- K. Electric Close Button: One for each electrically operated circuit breaker.
- L. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks where indicated on contract drawings.
- M. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key-interlock devices is indicated.
- N. Undervoltage Trip Devices: Instantaneous, with adjustable pickup voltage OR Adjustable time-delay and pickup voltage.
- O. Shunt-Trip Devices: Where indicated on drawings.
- P. The Port does not recommend Fused Circuit Breakers, but where required, comply with the following: Circuit breaker and fuse combinations complying with requirements for circuit breakers and trip devices and with the following:
1. Fuses: NEMA FU 1, Class L current limiting, sized to coordinate with and protect associated circuit breaker.
  2. Circuit Breakers with Frame Size 1600 A and Smaller: Fuses on line side of associated circuit breaker, on a common drawout mounting, arranged so fuses are accessible only when circuit breaker is in disconnected position.
  3. Circuit Breakers with Frame Sizes More Than 1600 A: Fuses and circuit breakers may be installed in separate compartments on separate drawout mountings. Fuse drawout element is interlocked with associated power circuit breaker to prevent drawing out fuse element unless circuit breaker is in open position.

4. Open-Fuse Trip Device: Positive means of tripping and holding circuit breaker in open position when a fuse opens. Open-fuse status is indicated at front of circuit breaker.
  5. Single phase sensing and protection is required with fuse limiters are used.
- Q. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

## **2.6 ACCESSORIES**

- A. Accessory Set: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.
1. Racking handle to manually move circuit breaker between connected and disconnected positions.
- B. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.
- C. Standby-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.
- D. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual. Locate near standby fuse cabinet.

## **2.7 IDENTIFICATION**

- A. Comply with labeling requirements in Section 260553 "Identification for Electrical Systems".
- B. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
  2. Medium: Tape.
  3. Color: Red.
- C. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:
1. Frame size of each circuit breaker.
  2. Trip rating for each circuit breaker.
  3. Conduit and wire size for each feeder.

- D. Torque Values: Provide self-adhesive machine printed label with connection torque values.

### **PART 3 - INSTALLATION**

#### **3.1 EXAMINATION**

- A. Examine elements and surfaces where switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 SWITCHGEAR INSTALLATION**

- A. Comply with applicable portions of NECA 400.
- B. Provide dedicated space for indoor switchgear per NEC Paragraph 110-26.
- C. Ensure that adequate space is provided at point of installation for code required working space, breaker draw-out space and access to front, sides and rear as required. Note that equipment sizes vary from manufacturer to manufacturer and space should be provided for largest equipment possible from any of the approved manufacturers.
- D. Ensure that pipes and ducts do not pass over or near switchgear per NFPA 70, Paragraph 110.26(E).
- E. Provide code working space, egress pathways and exit doors per NFPA 70, Paragraph 110-26. Provide yellow painted on the floor showing extent of code working space.
- F. Anchor switchgear assembly to 4-inch, channel-iron floor sill embedded in concrete base and attach by bolting.
  - 1. Sills: Select to suit switchgear; level and grout flush into concrete base.
  - 2. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 260548.16 "Seismic Controls for Electrical Systems" for seismic-restraint requirements.
  - 3. Concrete Bases: 3-1/2 high, reinforced, with chamfered edges. Concrete shall be a minimum of 3000 psi. Extend base no more than 3 inches in all directions beyond the maximum dimensions of switchgear unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Section 260529 "Hangers and Supports for Electrical Systems."
    - a. Concrete bases shall be leveled to no more than 0.25 inches of deviation for every 3 feet in ALL directions.
    - b. Contractor shall notify F&I and AV Maintenance prior to concrete pour to measure concrete base and assess base's levelness.
    - c. Concrete bases shall have smooth finishes. Broom finishes are prohibited.

- G. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

### **3.3 IDENTIFICATION**

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 260553 "Identification for Electrical Systems."
- B. Install phenolic labels on switchgear and breakers as specified in Section 260553 "Identification for Electrical Systems."
- C. Diagram and Instructions:
  - 1. Frame and mount under clear acrylic plastic on the front of switchgear.
    - a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
    - b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.
  - 2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

### **3.4 CONNECTIONS**

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Torque all lugs per manufacturer's recommendations. When manufacturer's recommendations are unavailable, use UL 486A and UL 486B for torque values. (Reference NEC Code Handbook 110-14).
  - 1. After torqueing of lugs, place a spot of red paint on lugs such that paint will be disturbed if lugs are disturbed.
- D. Generator Backfeed Application – Where required, switchgear shall be provided with backup generator connection point.
  - 1. Provide a fully-rated circuit breaker matching the bus ampacity of the switchgear. Breaker shall be the same type as the Main breaker(s) on the switchgear.
  - 2. Provide generator camlock connection cabinet sized for switchgear. Cabinet shall accept male camlock connectors. Provide male to female camlock adapters.
  - 3. Where space is limited, provide 10 feet cable with Posi-Lok male connector pigtails, and terminate cable to the load side of the breaker. Cables (with pigtails) shall be coiled neatly within the breaker compartment.
  - 4. If generator connection point is available, Contractor shall coordinate and ensure generator rental(s) are provided with the correct connector plugs. Contractor shall

provide connection adapters as required to connect rental equipment to existing generator connection point.

### **3.5 FIELD QUALITY CONTROL**

- A. Prepare for acceptance tests as follows:
  - 1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- B. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- C. Perform the following field tests and inspections and prepare test reports:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories, as applicable to project:
    - a. Switchgear.
    - b. Circuit breakers.
    - c. Protective relays.
    - d. Instrument transformers.
    - e. Metering and instrumentation.
    - f. Ground-fault systems.
    - g. Battery systems.
    - h. Surge arresters.
  - 2. Remove and replace malfunctioning units and retest as specified above.
- D. Check outdoor switchgear enclosures for leaks and assure proper operation of heaters.
- E. Test switchgear with 1000-Volt Megger for 480-Volt systems and 500-Volt Megger for 208-Volt systems after installation is complete. Megger switchgear with all draw-out units disengaged and again with drawout units engaged and circuit breakers open before energizing switchgear.
- F. Check phase rotation of all conductors and ensure proper color coding.
- G. Verify continuity and tightness of all ground connections.
- H. Infrared Scanning: After Substantial Completion, but not less than two weeks prior to Final Acceptance, perform an infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.
  - 1. Follow-up Infrared Scanning: The Port shall have the option of performing its own infrared inspection. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

- I. Existing low voltage drawout circuit breakers: Where modification is made to existing breaker settings, provide breaker test for modified breaker. Test shall test the functionality of the breaker including, but not limited to, visual and mechanical inspections, trip units and settings, insulation test and primary injection test.

### **3.6 ADJUSTING**

- A. Set field-adjustable, protective-relay trip characteristics according to results in Section 260573 "Power System Studies" and per engineer's coordination study and instructions.
- B. Attach calibration certification tag to all circuit breakers.

### **3.7 CLEANING**

- A. On completion of installation, inspect interior and exterior of switchgear. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

### **3.8 PROTECTION**

- A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

### **3.9 OPERATION AND MAINTENANCE MANUALS**

- A. Provide operation and maintenance manuals including manufacturer's technical information, parts lists, schematics/wiring diagram and recommended maintenance procedures.

### **3.10 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Port's maintenance personnel to adjust, operate, and maintain switchgear. Training shall be scheduled for three shifts, minimum 10 persons per training.

END OF SECTION 262300