PART 1  GENERAL

1.03  SCOPE

A. Work Included
   1. The Manufacturer shall furnish a fully assembled Outdoor Metal-Clad Switchgear as detailed in these specifications. Drawings, material lists, and other data included with the inquiry shall be considered part of the specifications. If conflicts exist between the written specifications and drawings provided, the written specification shall govern.

B. Work Not Included
   1. Connection of external power and control cables
   2. Anchoring of the switchgear
   3. Concrete foundation upon which the switchgear will be installed

1.04  RELATED SECTIONS

1.05  REFERENCES, CODES AND STANDARDS

A. The Applicable codes and standards listed below shall be considered part of this specification. The latest revision in effect on the date the request for proposal was issued shall apply for all standards referenced.

   1. National Electrical Manufacturers Association (NEMA)
      a. SG-2 Standards for High-Voltage Fuses
      b. SG-4 Standards for Power Circuit Breakers
      c. SG-5 Standards for Power Switchgear Assemblies
      d. SG-6 Standards for Power Switchgear Equipment

   2. National Electric Code (NEC)

   3. Institute of Electrical and Electronic Engineers (IEEE)
      a. IEEE C37.04 Standard Rating Structure for AC High Voltage Circuit Breakers
      b. IEEE C37.06 AC High-Voltage Circuit Breakers Rated on Symmetrical Current Basis – Preferred Ratings and related Required Capabilities
      c. IEEE C37.07 Reclosing Service for AC High-Voltage Circuit Breakers
      d. IEEE C37.09 Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
      e. IEEE C37.010 Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
      f. IEEE C37.1 Definition, Specification and Analysis of Systems Used for Supervisory Control, Data Acquisition and Automatic Control
g. IEEE C37.2 Electrical Power System Device Function Numbers and Contact Designations
h. IEEE C37.20.2 Standard for Metalclad and Station Type Cubicle Switchgear
i. IEEE C57.13 Standard Requirements for Instrument Transformers
j. IEEE C62.11 Standard for Metal-Oxide Surge Arresters for AC Power Circuits
4. American Society of Mechanical Engineers (ASME)
5. American Welding Society (AWS)
6. State Building Code Certification as required

B. It is the Manufacturer’s responsibility to be knowledgeable and to employ designs and manufacturing practices that incorporate the latest revision of these standards.

1.06 PROJECT DRAWINGS AND DOCUMENTATION
A. The Manufacturer shall submit the following information for Purchaser’s approval:
   1. Bill-of-materials, including the quantity, item description, manufacturer and catalog number of all components being provided
   2. Metal-Clad Switchgear plan view drawings, including mounting details (channel, sill, and anchor bolt locations), control and power cable entrances, bus duct entrances, roof bushing locations, weights, shipping splits, and door swing
   3. Front View Panel Elevations
   4. Elevation Views of the Metal-Clad Switchgear showing the location of all wall mounted equipment
   5. Cross section of each switchgear cubicle showing internal equipment arrangement
   6. One Line diagram
   7. Three Line diagram
   8. Electrical control schematics
   9. Electrical wiring diagrams (review only)

B. Drawings shall include the project name, jobsite location, and purchase order or contract number. A unique drawing shall be supplied for each cubicle. “Typical” drawings are not acceptable.

C. Wiring diagrams shall indicate the relative physical location and the terminal view of all components along with wiring connections. Wire lists are not acceptable

D. Wiring diagrams shall include the identification of shipping splits and shall clearly show all connections to be made by the Purchasers.

E. The Purchaser will review and approve drawings submitted by the Manufacturer within ten (10) working days of their receipt.

F. Within two weeks of completion of testing of the Metal-Clad Switchgear, the Manufacturer shall provide a complete set of final “as-built” drawings to the Purchaser on CD. The files shall be provided in both PDF and AutoCAD format
1.07 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.08 REGULATORY REQUIREMENTS

1.09 SHIPMENT AND DELIVERY

A. The Metal-Clad Switchgear shall be shipped FOB job site, freight prepaid and allowed. It shall be assembled as much as possible, taking into consideration the Purchaser’s site conditions. It is preferred that the Metal-Clad Switchgear be shipped as one complete assembly. Each shipment shall include provisions for lifting by crane. The Manufacturer will be responsible to provide qualified personnel to offload, place on the foundation and re-assemble shipping splits at the job site. The personnel provided for re-assembly shall be trained and experienced in the assembly of the Metalclad Switchgear.

B. The Metal-Clad Switchgear shall be protected from damage during shipment, including entrance of dust or moisture. The leading and trailing surfaces of each shipment shall be covered by self-adhering plastic to protect the surfaces during transport. The protective covering shall be easy to remove once the equipment is received without damaging the original finish.

1.10 OFFLOADING, FIELD ASSEMBLY AND TECHNICAL SERVICE

A. The Manufacturer shall provide a cost in the Bid Price Schedule for the services of a crane and factory trained technicians to offload and re-assemble the Metal-Clad Switchgear onto the Purchaser’s foundation. Assembly shall include the following activities:

1. Reconnect and weatherproof any shipping splits.
2. Reconnect control cables across shipping splits.
3. Uncrate and install circuit breakers in their respective cells.
4. Remove any shipping braces.
5. Re-install equipment packaged separately for shipment.
6. Install main bus splice bars across shipping splits.
7. Install roof bushings and roof mounted bus support stands (if applicable).
8. Install bus duct supplied with the switchgear (if applicable).
9. Uncrate and install batteries.
10. Inspect the equipment for any signs of damage during shipment and offloading.
11. Verify receipt of all items on the bill-of-lading, including items packed in boxes.
12. Verify that circuit breakers rack in and out of the cubicles smoothly.
13. Verify proper operation of safety interlocks.
14. Instruct Purchaser’s operating personnel in the proper handling of circuit breakers.

B. All travel and living expenses associated with providing this field service shall be included in the price.

C. The Purchaser will assume responsibility for installation and termination of all external cables prior to placing the equipment in operations

D. Training

1. The Contractor shall provide a training session for up to five (5) owner’s representatives for ________ normal workdays at a jobsite location determined by the owner.

2. A manufacturer’s qualified representative shall conduct the training session. Training program shall include instructions on the assembly, circuit breaker, protective devices, and other major components.

1.11 OPERATION AND MAINTENANCE MANUALS

A. Three printed copies of the Operation and Maintenance Manual shall be provided in quality binders. The manuals shall include a table of contents, an instruction manual and spare parts list for all major components, a set of as-built drawings reduced to 11” x 17” size and a copy of the factory production test reports. The Manufacturer shall also provide three copies of the Operation and Maintenance Manual on CD ROM in PDF format

PART 2 PRODUCTS

2.03 APPROVED METAL-CLAD SWITCHGEAR MANUFACTURERS

A. The Purchaser’s approved manufacturers are as follows:

1. Eaton
2:__________
3:__________

2.04 RATINGS

A. Environmental and Service Conditions

1. Ambient Temperature Range _____ °F to _____ °F
2. Relative Humidity _____ % lot to _____ % high
3. Maximum Wind Velocity (gust) _____ mph
4. Roof Load (Snow/Ice) _____ pounds per square foot
5. Average Annual Rainfall _____ inches
6. Excessive Dust or Blowing Sand _____ (Y?N)
7. Corrosive Atmosphere (If Applicable)_______ ______ ______ ______

* Note to Spec. Writer – Insert data in blanks
8. Altitude  
   _____ feet above sea level
9. Seismic Zone  
   _____
10. Wall insulation  
    R-11 to R-20
11. Roof Insulation  
    R-11 to R-30
12. Floor Insulation  
    R-14 minimum

B. General Description
1. The following switchgear units are to be provided, as shown on the one-line diagram

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Continuous Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incoming Main Circuit Breaker</td>
<td>_____</td>
<td>_____ A, rms</td>
</tr>
<tr>
<td>Bus Tie Circuit Breaker</td>
<td>_____</td>
<td>_____ A, rms</td>
</tr>
<tr>
<td>Feeder Circuit Breaker</td>
<td>_____</td>
<td>_____ A, rms</td>
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<tr>
<td>Future Feeder Compartment</td>
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<td>Capacitor Bank Circuit Breaker</td>
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<td>_____ A, rms</td>
</tr>
<tr>
<td>Auxiliary Cubicle</td>
<td>_____</td>
<td></td>
</tr>
</tbody>
</table>

| Minimum Aisle Width                        | _____ inches |
| Work Area Required                         | Y / N       |
| W(ft) x L(ft)                              | _____       |
| Two-high Breaker Arrangement Allowed       | Y / N       |
| Shipping Splits Allowed                    | Y / N       |

C. The switchgear shall be designed per the latest revision of IEEE Standard C37.20.2 for Metal-Clad Switchgear with the following electrical characteristics:

1. Rated Maximum Voltage  
   _____ kV, rms
2. Power Frequency Withstand  
   _____ kV, rms
3. Impulse Withstand Rating BIL  
   _____ kV, peak
4. Rated Continuous Current  
   _____ A, rms
5. Momentary rating  
   _____ kA, rms

D. Circuit Breaker Ratings and Specifications:

1. Breakers shall be horizontal draw-out vacuum type. All breakers of the same rating shall be mechanically and electrically interchangeable. Each breaker shall have the following characteristics:

   a. Rated Maximum Voltage  
      _____ kV, rms
   b. Rated voltage factor (k)  
      1.0
   c. Power Frequency Withstand  
      _____ kV, rms
   d. Basic Impulse Level (BIL)  
      _____ kV, peak
   e. Interrupting Capability  
      _____ kA
   f. Interrupting Time  
      3 or 5 cycles
   g. 2-Second Short Time Current Carrying Capability  
      _____ kA, rms
h. Closing and Latching Capability
   ______ kA, peak

i. Control Voltages (Specify AC or DC)
   ______

j. Close Coil
   ______ v____ c

k. Trip Coil
   ______ v____ c

l. Spring Charge Motor
   ______ v____ c

2. The following breaker manufacturers are approved (No substitutions are accepted):
   a. Eaton type VCP-W
   b. *__________
   c. *__________

3. Each vacuum circuit breaker shall have a dedicated control circuit protected by a (circuit breaker) (fused pullout block) (knife switch and fuse). All breakers shall be mechanically and electrically trip free. Breakers of the same type and rating shall be interchangeable. It shall be possible to use a 2,000A breaker in a 1,200A cell. Circuit breakers shall be operated by means of a stored energy mechanism that is charged by a universal motor. Once the stored energy mechanism is charged, it shall be possible to open, close and open the breaker without having to recharge the stored energy mechanism. Provisions shall be included to charge the spring mechanism using a manual handle. It shall be possible to manually trip or close the breaker from the front of the circuit breaker, once the stored energy mechanism is charged. The manual close and trip buttons shall be labeled accordingly. The closing speed of the contacts shall be independent of the control voltage.

4. Each breaker shall have a full front metal shield. It shall be possible to access and maintain the operating mechanism from the front of the breaker while it is installed in its cell. The circuit breaker frame shall be continuously grounded whenever it is installed in the cubicle by use of a sliding contact on the circuit breaker that mates with a ground bar in the bottom of the breaker cell. The front metal shield shall serve to enclose the breaker in its own grounded metal compartment when the breaker is in the fully connected position.

5. Secondary control circuits shall be connected automatically through a self-aligning and self-engaging plug and receptacle arrangement when the circuit breaker is racked into the connected position. It shall be possible for secondary control circuits to be manually engaged in the disconnected position. A total of __A and __B mechanism operated contacts (MOC) auxiliary contacts shall be provided. In addition, 5A and 5B auxiliary contacts that operate when the breaker is racked to the connected position (TOC) shall be provided.

Table 16346A-1

<table>
<thead>
<tr>
<th>Rated Maximum Voltage</th>
<th>BIL</th>
<th>Rated Short Circuit Current at Rated</th>
<th>Rated Voltage Range Factor</th>
<th>Maximum Symmetrical Interrupting and 3-Second Closing and Latching Capability (Momentary)</th>
<th>Nominal 3-Phase MVA Class</th>
</tr>
</thead>
</table>

* Note to Spec. Writer – Insert data in blanks

16346B-6

03/03/14
## 2.05 METAL-CLAD SWITCHGEAR ENCLOSURE CONSTRUCTION

A. The switchgear shall be installed in an outdoor weatherproof Metal-Clad Switchgear enclosure that is thermally insulated and environmentally conditioned. All steel shall be cut using a high energy laser for accuracy and to prevent sharp metal edges. The enclosure shall include a maintenance aisle and work area, as shown on the plan view drawing. The walls and roof of the Metal-Clad Switchgear enclosure shall be fabricated from 11-gauge steel and be assembled onto a structural steel base. The enclosure shall be rodent-proof and weatherproof. All bolts utilized in the construction of the enclosure shall be minimum $\frac{3}{8}''$, grade 5. Welded studs shall be minimum $\frac{9}{16}''$, grade 2, nickel-plated. The roof shall be supported by full depth, dual roof trusses that are bolted together and spaced at 36” intervals. Roof panel bolting hardware shall include neoprene bonded stainless steel washers on each side to weatherproof the bolt threads and holes. Roof panel joints shall be protected from exposure to the elements by a full depth roof cap. All exposed external hardware shall be stainless steel. The design and construction of the enclosure shall

<table>
<thead>
<tr>
<th>V (kV RMS)</th>
<th>kV Peak</th>
<th>Maximum Voltage (kA RMS sym)</th>
<th>Short Time Current Carrying Capability (kA RMS sym)</th>
<th>kA Crest</th>
<th>MVA</th>
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<tr>
<td>4.76</td>
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minimize the use of gaskets and prevent the entrance of moisture and dust. Gaskets shall be limited to doors, power and control cable entrance cover plates and between the base and walls. All roof and wall seams shall be caulked with an extended life silicone sealant. External hardware shall utilize welded studs to prevent ingress of moisture. The enclosure and base shall be capable of being extended from either end in the future.

B. The Metal-Clad Switchgear enclosure design shall have successfully passed a Rain Test per IEEE Standard C37.20.2-1999, section 6.2.10. Copies of certified test results shall be provided upon request.

C. OSHA approved anchors shall be provided at the roof peak and spaced every 36” for attachment of personal fall arrest protective equipment. The anchor and its mounting attachment shall have been tested to a tension of 5,000 lbs.

D. The base shall be constructed of welded structural members that provide a rigid, square and level foundation for the enclosure. The base shall be capable of withstanding stresses resulting from skidding, rolling, or lifting of a shipping section with all equipment installed. The base shall be designed such that it can be installed on a foundation with the power cable compartments cantilevered over a flat pad or on piers. Cutouts with 1/8” thick aluminum cover plates shall be provided in the floor at locations where conduits enter the enclosure. Crossbeams and channels shall be positioned to ensure complete access to cutouts while maintaining structural integrity. Lifting provisions shall be permanently welded to the base at all four corners of each shipping split. Base sections at shipping splits shall be designed so adjoining base sections can be bolted together to maintain structural rigidity. Access to shipping split base connecting hardware shall be through cutouts in the floor on each side of the split. Cover plates over the floor cutouts shall be designed to fit flush with the floor and utilize hardware that is countersunk and flush with the floor after installation. The base shall be insulated with spray-on polyurethane foam to meet the R rating specified in paragraph 3.4.

E. Thermal insulation shall be installed under the entire roof (including the roof over the switchgear) and in all walls to meet the R ratings specified in paragraph 3.4. The insulation shall be closed-cell foam that will not sag or absorb moisture and can be cut to fill all spaces. 14-gauge steel interior panels shall cover and protect wall insulation. Interior ceiling panels shall be 16-gauge steel. Roof and wall panels shall receive a protective finish coat on all surfaces before insulation is installed. Walls shall be designed for mounting of equipment without reducing structural ratings.

F. The enclosure shall have a personnel door at each end to allow for safe emergency egress. Personnel doors shall be forty-two inches (42”) wide to allow the removal of equipment from the enclosure. An adjustable pneumatic door closing mechanism shall be provided at the top of each door. Doors shall have magnetic weather-stripping and tamper resistant hinges. Each door shall be equipped with panic hardware on the inside and a thumb latch assembly with cylinder lock on the outside. The cylinder shall be fitted with a lock that matches the Purchaser’s standard key system. It shall be possible to open the doors from the inside, even when they are locked from the outside. Doors shall include thermal insulation rated R15 minimum.

G. A hinged, full height, rear door shall be provided for access to each power cable compartment. The door shall be weather tight and include a three-point latching mechanism and stainless steel handle with provisions for padlocking. Hardware at latching points shall be nylon rollers. When closed, the door shall be flush with the enclosure. A compressible
automotive type gasket shall be provided on the top, bottom and sides of the door to prevent entrance of moisture and air borne contaminants. A drip shield, attached to welded studs, shall be provided above each door. A door holding mechanism shall be installed at the bottom of each door that automatically engages when the door is fully opened and held in position by a spring. It shall be possible to disengage the door holding mechanism using downward force only. The door holding rod shall not bend due to an attempt to close the door without releasing the mechanism. Each door shall have ventilation openings at the top and bottom. A protective hood shall be installed over each vent opening to inhibit the entrance of blowing rain, snow or dust during turbulent wind conditions. Each hood shall contain a cleanable and re-usable aluminum filter and insect screen. The filters shall be accessible from the outside without opening the door.

H. A wall-mounted HVAC system shall be provided that is a self-contained energy efficient heating and cooling system. The HVAC shall include a barometric fresh air damper. An economizer shall be provided that allows the system to operate as a vent fan. The HVAC shall be sized to maintain an inside temperature of not more than 80°F and not less than 55°F based on the maximum and minimum ambient conditions specified in Section 3.4. An electronic thermostat shall be provided that allows programmed settings for operation of the HVAC. The thermostat shall allow separate settings for heating and cooling and include a digital readout. An internal battery shall maintain settings during a power outage.

I. The distance from the aisle floor to the ceiling shall be 9ft. 5in. minimum to accommodate installation of a wireway or cable tray above the switchgear. A six-inch space shall be provided between the switchgear and end walls to allow for door swing and the use of a breaker lift device on end cubicles.

J. Floor plates shall be fabricated from 7 gauge steel. The floor plates shall be welded and supported by structural steel angle supports in the base that are spaced on 12” centers. The floor shall have a load rating of 300 pounds per square foot. The floor shall be coated with a skid resistant epoxy finish that is fully cured prior to assembly. Open floor areas shall to be protected by masonite sheets during assembly, wiring and testing. The masonite sheets shall be left in place during shipment to protect the floor during field installation and site testing. The sheets may be discarded when the equipment is placed into full time service.

K. The Metal-Clad Switchgear enclosure shall be provided with the following equipment:
   1. Ambient compensated, dual lamp, 120vac fluorescent fixtures with energy efficient type T8 lamps, controlled by 3-way switches located at each personnel entrance door. The lighting shall maintain a minimum lighting level of 30 foot-candles at floor level. Each lamp shall be provided with a protective cover.
   2. Emergency exit signs located above each personnel exit door.
   3. Smoke and heat detectors mounted on the ceiling.
   4. A photocell controlled, 70-watt, high-pressure sodium exterior light located over each personnel entrance door.
   5. 120VAC, 20amp, duplex ground fault type receptacles located inside near each personnel door.
   6. Document reference table with a smooth horizontal surface, 48” long x 24” wide, at a height of 40” above the floor. The table shall be provided with a hinge mechanism that allows it to be stored against the wall when not in use.
   7. A __” x ___” plywood board for mounting of telephone equipment.
OUTDOOR METAL-CLAD MEDIUM VOLTAGE SWITCHGEAR
SECTION 16346B

8. Circuit breaker test cabinet
9. Automatic AC transfer switch
10. AC Panelboard
11. A plywood board with provisions for storage of switchgear accessories and tools.
12. Office desk and chair
13. Rack to hold a set of full size drawings

L. An Interface Termination Cabinet (ITC) shall be provided for termination of external low voltage control connections. All external control connections shall be wired to terminal blocks located in the ITC. The ITC shall be located on the interior of the Metal-Clad Switchgear and be fabricated from 11-gauge steel. The interior shall be high visibility white and the exterior ANSI 61 grey. Cables from the switchgear and other equipment in the Metal-Clad Switchgear shall enter from the top and be connected to the left side of the terminal blocks. Connections external to the Metal-Clad Switchgear will be made on the right hand side of the terminal blocks. A cable riser enclosure shall be provided on the outside of the Metal-Clad Switchgear to interface with a control cable pit and shall include an adjustable telescoping section at the bottom. A ladder tray shall be installed inside the cable riser that passes through the Metal-Clad Switchgear enclosure wall and terminates at the top of the Interface Terminal Cabinet.

2.06 COLD ROOF DESIGN (OPTION)

A. The Metal-Clad Switchgear enclosure shall incorporate a cold roof design to prevent the formation of ice dams on roof surfaces due to melting of snow. The design shall inhibit the heat generated by energized equipment and heating systems from raising the temperature of the roof surface.

B. The cold roof shall incorporate the following construction features:

1. An open air space shall be provided between the ceiling insulation and roof to maintain the interior surface of the roof at or near the temperature of the exterior roof surface.

2. Spray-on foam shall be utilized to fill all dead air space in the ceiling insulation to inhibit the passage of warm air into the space above the ceiling. The thermal rating of the ceiling insulation shall be R21 minimum.

3. Vents, spaced every 36 inches, shall be located along the roof eaves on front and rear sides of the Metal-Clad Switchgear enclosure. These vents shall incorporate hoods to prevent the ingress of blowing snow or rain.

4. In order to maintain a positive airflow, the net free area of vent openings in the eaves must be equal to or greater than the net free area of vent openings in the chimneys. A minimum of one square foot of net free vent area shall be provided per 150 square feet of ceiling area.

5. Venting at the peak of the roof shall consist of 18" tall chimneys attached to flanges that are continuously welded into the roof surface. The flanges shall be designed to prevent entry of moisture under all weather conditions. A cap shall be provided at the top of each chimney to prevent ingress of blowing snow or rain into the vent openings.
6. No venting shall be installed at roof end gables, since doing so will cause uneven distribution of ventilating air and allow blowing snow or rain to be drawn into the air space between the ceiling insulation and roof.

7. The design shall be reviewed and approved by a licensed professional engineer with cold roof design expertise in regions that encounter substantial snow accumulations and extended periods of cold temperatures.

C. The bidder must provide a written description along with drawings that describe the details of the cold roof design they are proposing. In addition, each bidder must provide evidence of successful cold roof installations with references for contact purposes.

2.07 METAL-CLAD SWITCHGEAR CUBICLE DESIGN

A. Each Metal-Clad Switchgear cubicle shall be welded from 11-gauge steel to form a rigid box that will not deform due to stresses associated with shipping and installation. All steel shall be cut using a high energy laser for accuracy and to prevent sharp metal edges. When cubicles are bolted together, there shall be two thicknesses of 11-gauge steel between adjacent cubicles. All doors, compartment covers and barriers shall be fabricated from 11-gauge steel. All metal work shall be free from burrs and sharp edges. The interior of each switchgear cubicle shall be coated white to enhance visibility. No unpainted or galvanized panels shall be utilized anywhere in the switchgear cubicles.

B. Front doors shall have a double return on the vertical edge with welded corners for strength and rigidity. Each door shall be provided with a dual position holder that has a mechanical stop for maintenance, as well as for installation/removal of a circuit breaker. Rubber inserts shall be provided on door flanges to protect mating surfaces. Each door shall include a minimum of two T handle door latches.

C. An interlocking system shall be provided to prevent racking a closed circuit breaker to or from any position. The stored-energy operating mechanism springs shall automatically discharge when a breaker is removed from or inserted into the breaker compartment. An insulating barrier and set of movable shutters shall isolate primary connections when the breaker is withdrawn.

D. The racking mechanism to move a circuit breaker between positions shall be accessible and operable with the front door closed and latched. There shall be adequate electrical and mechanical clearance between door-mounted devices and the breaker with the door closed and the breaker in the fully withdrawn position. A remote racking motor with twenty foot long cable and control station shall be provided so breakers can be racked in or out electrically without requiring the operator to stand in front of the breaker cubicle. Each breaker door shall have provisions to mount the remote racking motor assembly. A receptacle to provide power for the motor shall be installed on each breaker cubicle door.

E. The following safety features shall be provided in each breaker cubicle, in addition to those required by IEEE Standards.

1. The insulating barrier in front of the primary connections in each breaker cell shall be labeled to indicate ‘Line’ and ‘Load’ bus connections, as well as phasing.

2. The load side bus shall be labeled to indicate phasing.

3. It shall be possible to padlock the breaker cell so a breaker cannot be inserted into the cubicle with the padlock in place.
F. Provisions for termination of power cables shall be located in the rear of each breaker cubicle. A floor opening with a 1/8" thick aluminum cover plate shall be provided to accommodate up to four 6" conduits. Each power cable compartment shall include a 1-5/8" unistrut cable support that is field adjustable in the horizontal plane. The distance between the floor and cable terminations shall be 36" minimum to accommodate installation of stress cones. PVC boots shall be provided for all cable terminations.

G. Connection to the main breaker shall be as indicated below. Please refer to the appropriate specification section if bus duct or roof bushings are indicated.

1. [ ] ___kV cables, _____MCM, ___ per phase entering from (bottom)(overhead)
2. [ ] ___kV, _____ amp, non-segregated phase bus duct
3. [ ] ___kV, _____ amp, roof bushings

H. Connections to feeder breakers shall be as indicated below.

1. [ ] ___kV cables, _____MCM, ___ per phase entering from (bottom)(overhead)

I. Strip heaters shall be provided and appropriately sized to prevent condensation. One strip heater shall be provided in each breaker cell and two strip heaters shall be provided in each outgoing or incoming power cable compartment. Heaters shall be rated 240Vvac, but operated at 120vac.

2.08 BUS

A. Bus shall be fabricated from full round edge, electrical grade copper alloy 110. All bus bars shall be fully silver-plated. The phase orientation shall be A - B - C, top to bottom, front to back, and left to right, when viewed from the front of the switchgear. The main bus shall be sized for the continuous current rating specified in section 3.6. Tapering of the bus size will not be permitted.

B. All medium voltage bus shall be insulated with epoxy. The epoxy coating shall be applied using a fluidized bed process controlled by a PLC to insure consistent results every time. Use of extruded sleeves or heat shrink insulation is not acceptable.

C. All bus bars shall be supported on cycloaliphatic epoxy or wet process porcelain insulators and be capable of withstanding the mechanical forces imposed by the short-circuit current ratings specified in paragraph 3.6. Use of glass-filled polyester, dry process porcelain, ceramic or non-cycloaliphatic epoxy formulations for bus supports is not acceptable. All bus supports must have the same BIL rating as the switchgear.

D. A ground bus shall be located at the bottom of each cubicle and extend the entire length of the switchgear assembly. It shall be securely bolted to the frame of each unit. The ground bus shall be extended to the rear of each power cable compartment and drilled to accommodate termination of the cable ground shield. The ground bus and ground bus extensions shall be capable of carrying the rated momentary current of the Metal-Clad Switchgear for two (2) seconds. In no case shall the bus be smaller than ¼"x2". The ground bus shall be connected to the Metal-Clad Switchgear ground grid

E. Bus connections shall utilize a minimum of two cadmium plated, ½", S.A.E. Grade 5 bolts, torqued to 55 ft.-lbs. Bolting hardware shall consist of a flat washer under the bolt head and a Belleville lock washer under the nut. All bolt holes shall be 9/16", punched or drilled.

F. The main bus and ground bus shall be supplied in unit lengths that will permit the re-assembly, re-configuration or addition of the units in the field.
G. The medium voltage feed-thru bus supports between cubicles shall be flame retardant, track resistant, cycloaliphatic epoxy. A PVC insert shall be provided around the insulated bus at feed-thru supports to prevent the inception of corona.

H. All phase bus connections shall have removable, pre-formed insulating boots, secured with Christmas tree type nylon fasteners that are easily removable and re-usable.

2.09 BUS DUCT (IF APPLICABLE)

A. The Manufacturer shall furnish a _____ amp, non-segregated phase bus duct to connect between (Purchaser to specify) and the incoming source side of the main breaker(s). The Manufacturer shall be responsible for coordinating the bus duct design with the transformer throat and secondary bushing locations.

B. The bus duct enclosure shall be constructed from 11-gauge steel for ratings of 2,000 amps and below and aluminum for ratings above 2,000 amps. The enclosure shall be totally enclosed, non-ventilated and weatherproof. Removable covers shall be gasketed and bolted. The bus duct shall include wall flanges, vapor barriers, fire barriers, expansion joints, equipment terminations and structural supports, as required.

C. The bus duct shall have the same short circuit, thermal, mechanical, and momentary ratings as the switchgear. A termination box shall be furnished at the transformer with bottom access to the flexible connections at the transformer bushings. All bolts, washers, nuts, belleville washers and flexible connectors required for connecting the bus duct to the switchgear and to the transformer terminals shall be furnished by the switchgear manufacturer. The transformer manufacturer will supply a flat four-hole pad on the transformer secondary bushings.

D. The bus duct conductors shall be full round edge copper and be silver plated at connection points. The conductors shall be insulated with fluidized bed epoxy. Bus joints shall utilize two splice plates and be insulated with removable boots. The conductors shall be sized to carry the rated current continuously without exceeding a temperature rise of 65°C above a 40°C ambient. Conductors shall be braced to withstand the momentary fault current rating of the switchgear. Bus shall be supported by cycloaliphatic epoxy or wet process porcelain insulators. A continuous ground bus shall be provided in the bus duct to ensure electrical continuity and minimize the possibility of circulating currents.

E. Strip heaters shall be installed in all outdoor sections of the bus duct to prevent condensation. The strip heaters will be rated 240 VAC and connected at 120 VAC. Strip heaters shall be installed in a junction box on the bottom side of the bus duct so that is possible to access them externally.
2.10 ROOF BUSHING SPECIFICATION (IF APPLICABLE)

A. Bushings shall be molded from wet process porcelain and have the following ratings:
   1. Continuous current rating  _______ amps rms
   2. Voltage Class  _______ kV
   3. BIL Rating  _______ kV

B. Roof bushings shall be threaded at the top to accept a stud connector. They shall be
   installed with a centerline to centerline distance of ___ inches and arranged as shown on the
   plan view drawing. Roof mounted support stands shall be provided as shown on the plan
   view drawing. Each support stand shall be fabricated from galvanized structural angles and
   include provisions to install standoff insulators.

2.11 CONTROL WIRING/TERMINATIONS

A. Switchgear secondary wiring shall be multi-stranded, tinned, copper conductor, type SIS,
   600 volt, VW-1 rating. Minimum control wire size shall be #14 AWG, 41 strand. Signal wiring
   (transducer outputs, etc.) shall be #22 twisted shielded pair. RTU connections shall be #18
   AWG, 18 strand, type SIS. Splicing or tapping is not permitted.

B. All wiring shall be fitted with solderless, insulated, ring-type compression terminal
   connectors. Terminals shall be attached using a ratcheting type crimping tool that cannot be
   released until a proper crimp is made. No more than two wires may be attached to any one
   terminal point.

C. A slip-on identification sleeve shall be provided at both ends of each conductor. It shall be
   possible to rotate the sleeve so that the marking is visible at all times. Markings shall be
   made with indelible ink that will not fade or smear. Each sleeve shall be marked with the
   opposite end destination location, as indicated on the wiring diagrams. Adhesive held wire
   labels are not acceptable.

D. Terminal blocks shall have screws with binder head washers and be rated 30 amps at 600
   volts. Terminal blocks shall accept ring tongue type terminals and include a marking strip for
   terminal identification. A minimum of 10% spare terminals shall be provided for the
   Purchaser’s use.

E. Terminal blocks, fuse blocks and other low voltage devices shall be attached to unistrut
   channels welded to side walls of the enclosure. Bolted device sheets shall not be utilized.
   Extra unistrut channels shall be provided for the Purchaser’s use.

F. All wiring between cubicles shall be installed in raceways that are no more than 70% filled.
   A separate raceway shall be provided for the Purchaser’s control wiring. Wiring between
   cubicles shall terminate on terminal blocks at both ends. Interconnecting wiring between
   shipping splits shall be coiled, properly tagged and supported for shipment.

G. Fiber optic cables shall be segregated from other wiring and protected against damage.
   Care should be taken to assure that a suitable bending radius is maintained for fiber optic
   cables so the cable is not cramped.

H. Wiring between hinged and stationary panels shall be supported to prevent undue stress
   and shall be protected from contact with metal edges by suitable protective wrap. All wiring
   between the door and cubicle shall cross the hinge at a point above the height of the circuit
   breaker to eliminate the possibility of interference with the breaker element.
I. All wiring shall be firmly bundled and secured to ensure it will remain in its intended location and not interfere with the operation of any device. Wire bundles shall be secured with cable ties attached to welded studs. Adhesive type hold-down clamps are not acceptable.

J. All electrical circuits for lighting and control power located outside the switchgear cubicles shall conform to the NEC. Aisle wiring shall be installed in conduit or wireway.

2.12 CONTROL, INDICATION, AND RELAYING DEVICES

A. Instruments, meters, relays and control devices shall be provided as shown on the panel front views, one line diagram and as listed in the specification bill-of-materials.

B. Instruments, meters, relays and control devices mounted on the switchgear front doors shall be semi-flush panel mounted or rack mounted.

C. The main contacts of all switching devices shall be silver plated. The contact surfaces of secondary disconnecting devices and relays shall be silver plated.

D. Protective relays, meters and lockout relays shall be provided with test switches that isolate all used inputs and outputs.

E. The breaker control circuit shall be wired to a heavy duty receptacle mounted on the breaker front door. A thirty foot (30') control cable shall be provided with matching plug at one end and control station at the opposite end. With the control cable plugged into the receptacle, the control station shall be capable of opening or closing the breaker without requiring the operator to stand in front of the breaker cubicle.

F. Indicating lights shall be long life LED type designed for maximum visibility. Lamps shall be replaceable without opening the cubicle door.

2.13 AUXILIARY DEVICES

A. Surge Arresters

   1. _kV (Station)(Intermediate)(Distribution) class, polymer type surge arresters shall be provided, as shown on the one-line drawing.

B. Voltage transformers shall be supplied as shown on the one-line diagram. The voltage transformers shall be mounted on tilt-out trunnions or drawout drawer assemblies and equipped with current limiting primary fuses. In the withdrawn position, the fuses and the potential transformers shall be disconnected and grounded to permit safe inspection and/or replacement of the fuses. The trunnion frame shall be connected to ground by a flexible copper cable that is attached directly to the frame. The mechanism shall be arranged so that full access to potential transformers or fuses cannot be accomplished until they are disconnected from high voltage and grounded. Live parts shall be isolated when the voltage transformers are in the withdrawn position to prevent accidental contact by operating or maintenance personnel. Stationary contacts shall be silver plated copper and mounted on porcelain or glass polyester supports. Cables connected to voltage transformer primaries shall be rated for the full voltage and BIL rating of the switchgear.

C. Current Transformers

   1. Current transformers shall be window-type mounted over the primary bottles in the breaker cell. Current transformer ratios and relay accuracy class shall be as shown on the one-line diagram. Current transformers shall have a 5 amp secondary and shall
be single or multi-ratio, as indicated. All secondary terminals of each current transformer shall be wired to easily accessible shorting type terminal blocks.

D. Station Service Transformers

1. Station Service Transformers (SST) of the quantity and rating shown on the one line diagram shall be provided. Each SST shall be fixed mounted and fed by primary current limiting fuses mounted on a tilt-out trunnion or drawout drawer assembly. When moved to the withdrawn position, the fuse(s) shall be automatically disconnected and grounded. Visible indication of a positive ground is required. The trunnion frame shall be connected to ground by a flexible copper cable that is attached directly to the frame. Cables used for connection to primary fuses shall be rated for the full voltage and BIL level of the switchgear. The SST shall be mechanically interlocked with the operating mechanism of a molded case breaker connected to the transformer secondary so that any load is removed prior to withdrawal of the primary fuses. The SST shall be epoxycast, have the same BIL rating as the switchgear and be provided with two (2) - 2½% taps above and two (2) - 2½% taps below the rated voltage. Secondary voltage shall be (120/240vac, single phase, three wire)(120/208vac, three phase, four wire).

E. AC Panelboard

1. A __ circuit AC panelboard with ___A (main lugs)(main breaker), rated (120/240vac, single phase, three wire)(120/208vac, three phase, four wire) shall be provided. Bus shall be copper with silver plated connections. All breakers shall be bolt-on type with a minimum interrupting rating of 10ka.

F. 125 VDC Station Battery System

1. Lead Acid Battery
   a. A 125vdc sealed, valve regulated, lead acid station battery shall be provided. The battery shall be designed and sized to deliver power to all continuous and non-continuous loads during an eight-hour outage. The duty cycle shall be an initial trip-close-trip followed by a final close-trip-close sequence. The battery shall be furnished with all required accessories and mounting hardware including inter-cell connectors, connecting bolts, end lugs, terminal connectors, flame arrester vent caps and hydrometer with holder. The battery shall have a minimum useful life expectancy of 20 years.

2. A two tier battery rack shall be provided and rated for the seismic zone listed in paragraph 3.4. A stainless steel or acid resistant polymer pan shall be installed underneath the battery rack to protect the floor surface from battery acid spills.

3. A weatherproof, screened exhaust fan, controlled by a cycle timer, shall be located above the battery to prevent buildup of hydrogen during charging. In addition, a hydrogen detector shall be mounted above the battery to provide an alarm indication should the concentration of hydrogen reach 0.1%.

G. Battery Charger

1. A solid state battery charger shall be provided that will recharge a fully depleted battery within 8 hours, in addition to supplying all continuous station DC loads. The battery charger shall be a constant potential, silicon controlled rectifier type. The charger shall operate from a single phase, 240 VAC power source. The charger output shall be filtered so that it may be operated as a battery eliminator with the battery disconnected.

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AC ripple shall not exceed 30mv rms. Efficiency at rated load shall be eighty-five percent (85%) minimum.

2. The charger shall include the following options:
   a. Float/Equalize mode switching and adjustment
   b. Surge protection
   c. Adjustable current-limiting circuitry
   d. 0 - 72 hour equalize timer
   e. Output ammeter and voltmeter with isolation fuses.
   f. Input and output thermal magnetic circuit breakers
   g. AC input & DC output power failure alarm
   h. DC high and low voltage alarm
   i. DC battery discharging alarm
   j. DC ground detection indication and alarm
   k. DC battery low voltage alarm
   l. Charger common alarm with audible alarm

H. Eyewash Station
   1. A self-contained, gravity fed eyewash station shall be supplied that is designed to deliver fluid to both eyes simultaneously at a volume of not less than 0.4 gallons/minute for 15 minutes. Enough fluid for two charges shall be included.

I. DC Panelboard
   1. A ___ circuit DC panelboard with ___ A (main lugs)(main breaker), rated 125 VDC shall be provided. Bus shall be copper with silver plated connections. All breakers shall be bolt-on type with a minimum interrupting rating of 10ka.

2.14 OWNER METERING
   A. Provide owner metering devices where shown on the drawings. Where indicated provide a separate owner metering compartment with front hinged doors. Include associated instrument transformers.
   B. Provide current transformers for each meter. Current transformers shall be wired to shorting type terminal blocks.
   C. Potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the drawings.

2.15 NAMEPLATES
   A. Engraved nameplates shall be provided for all equipment mounted on the doors. The nameplates shall be laminated white with black lettering. They shall be secured with stainless steel screws or double adhesive foam tape. Lettering shall be 3/8” high minimum. Lettering shall be bold so that it can be easily read at a distance of ten feet.
   B. Self-adhesive labels shall be located next to all interior mounted devices. The labels shall be imprinted with device designations that correspond to those used on the wiring diagrams.
2.16 METAL SURFACE PREPARATION AND PROTECTION

A. All steel surfaces shall be power washed and phosphatized, followed by application of a corrosion inhibitor prior to coating. Aluminum surfaces shall be cleaned and micro-etched prior to receiving a protective coating.

B. After each piece has been cleaned and oven dried, it shall be coated with electrostatically applied polyester powder to a final baked-on thickness of 1.5 to 2.0 mils dft for interior surfaces and 2.5 to 3.0 mils dft for exterior surfaces. All steel surfaces must receive a finish coat. Uncoated surfaces or galvanealed panels are not permitted.

C. Exterior Metal-Clad Switchgear enclosure surfaces shall be high gloss ANSI 70 light gray.

D. The interior walls and ceiling shall be high visibility white.

E. The switchgear cubicle interiors shall be high visibility white.

F. The switchgear front doors shall be ANSI 61 gray.

G. Open floor areas shall be protected by a gray, non-skid epoxy finish.

H. The bottom of the structural base shall be protected with an asphaltic compound that does not harden over the life of the equipment.

I. The sides of the structural base shall be coated with an epoxy compound that is resistant to corrosion and designed for coating of structural steel.

J. The protective polyester powder coating shall have the following minimum characteristics based on ASTM tests applied to samples utilizing the coating proposed. Copies of test results and/or data from the coating manufacturer certifying this capability shall be included with the proposal.

<table>
<thead>
<tr>
<th>ASTM Test</th>
<th>Characteristic Measured</th>
<th>Minimum Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>D3363</td>
<td>Resistance to marring and scratches</td>
<td>2H-4H</td>
</tr>
<tr>
<td>D3170</td>
<td>Resistance to chipping by impact</td>
<td>5A</td>
</tr>
<tr>
<td>D2794</td>
<td>Resistance of cracking – direct impact</td>
<td>160 in-lbs</td>
</tr>
<tr>
<td>D2794</td>
<td>Resistance to cracking – indirect impact</td>
<td>160 in-lbs.</td>
</tr>
<tr>
<td>B1117</td>
<td>Resistance to corrosion</td>
<td>1,000 hrs</td>
</tr>
<tr>
<td>QUV340A</td>
<td>Gloss retention and color fastness</td>
<td>10% loss @2,000 hrs</td>
</tr>
</tbody>
</table>

2.17 SWITCHGEAR ACCESSORIES

A. The following accessories shall be provided for the switchgear:

1. Manual breaker spring charging handle
2. Manual breaker racking tool
3. Remote racking motor assembly with cable and control station
4. Remote control cable with plug and control station for breaker operation
5. Test cable to allow testing of a circuit breaker outside of the breaker cell
6. Test plug of each size and type for relays and/or test switches
7. Breaker test cabinet

2.18 FACTORY TESTING

A. Design Tests
1. The Metal-Clad Switchgear shall be an integrated assembly that is designed, manufactured, assembled and tested as a complete assembly at one facility.
2. The equipment being proposed shall have passed applicable IEEE Design Tests. Copies of test certifications shall be provided to the Purchaser upon request.

B. Factory Production Tests
1. The Manufacturer shall perform production tests required by applicable IEEE Standards and these specifications. Testing shall be performed on all equipment being provided with the Metal-Clad Switchgear, as an integrated assembly, and shall include the following:
   a. Mechanical Operation Tests
   b. Instrument Transformer Case Grounding Tests
   c. Power Frequency Withstand Test (AC Hi-Pot)
   d. Instrument Transformer Ratio Tests
   e. Functional Tests of all Control and Protection Circuits
2. Each circuit breaker for the project shall be uncrated and inserted into a switchgear cubicle to verify mechanical alignment and proper electrical operation. Interchangeability of breakers of the same rating shall be verified. Circuit breakers must be delivered with the switchgear.
3. A set of production test reports shall be included in each instruction manual.

C. Customer Inspection and Witness Testing
1. The Purchaser reserves the right to inspect the equipment during manufacturing and/or witness tests prior to shipment. The Manufacturer shall notify the Purchaser at least two weeks prior to the date the equipment is available for witnessing of tests. Waiving of witness tests shall not relieve the Manufacturer from the responsibility of furnishing equipment and material in accordance with these specifications.

2.19 FIELD TESTING

A. Field testing and commissioning should be performed by a 3rd party.