Indoor and Outdoor Medium Voltage Metal-Clad Switchgear
Outdoor Power Control Enclosure
Installation Instructions

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Safety Warnings

Omaha Power Center equipment is designed to meet all applicable NEMA and IEEE standards in effect at the time of manufacture. Successful application and operation of this equipment depends as much upon proper installation and maintenance by the user as it does upon the quality of workmanship provided by Omaha Power Center.

The purpose of this installation manual is to assist the user in developing safe and efficient procedures for the installation of the equipment. This manual is intended for persons familiar with this type of equipment and is not intended for inexperienced personnel. Contact Omaha Power Center if any additional information is desired.

All personnel involved in the installation of this equipment should be properly trained and supervised regarding power equipment.

Personnel should wear proper safety clothing, face and eye protection, and any other required safety gear that will assist in preventing injury when installing this equipment.

Omaha Power Center assumes no responsibility for any user practices that deviate from the recommendations in this manual that may cause damage to property or injury to personnel.
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General Description

These instructions cover the installation of Omaha Power Center (hereafter referred to as OPC) indoor and outdoor metal-clad switchgear and outdoor power control enclosures. Figures shown in this manual represent typical installations. All diagrams, descriptions and instructions apply to all voltage classes and designs unless noted otherwise. Standard construction details of the equipment, auxiliary equipment and necessary accessories are given in the appropriate sections. Other mechanical and electrical devices, furnished in accordance to user specification, are covered by supplementary instructions included in the Operation & Maintenance Manual. Ratings described in this manual are in accordance with NEMA, IEEE and ANSI standards.

The term medium voltage in this manual is used to describe the system voltage of the equipment, including, but not limited to, bus and vacuum circuit breakers. This term will be used when describing equipment designed to operate at this voltage. The terms “control”, “low” and “secondary” voltage describe the relay, control power, aisle components and various other low voltage equipment.

The switchgear described in this manual is metal-clad type. All medium voltage parts are completely enclosed within grounded metal barriers. Secondary control devices and primary circuits are isolated from each other by shutters or barriers. Primary circuits of different potential are also separated by barriers. All primary bus work and joints are completely encased with insulation material to suit the voltage class of the equipment.

Indoor switchgear equipment is intended for installation in a clean, dry and climate controlled indoor environment.

Outdoor aisle-less switchgear equipment is of weatherproof construction. Front and rear sealed outdoor type doors enclose the instrument panel and circuit breaker compartments.

Outdoor sheltered aisle-type switchgear equipment consists of switchgear equipment enclosed in a weatherproof enclosure, complete with an illuminated, walk-in aisle space in front of the switchgear cubicles. Circuit breakers can be rolled out into the aisle and serviced without exposure to the elements. Controls, instrumentation, and relaying can be maintained without exposure to the elements. This equipment is designed to be installed outdoors and operate in all types of weather.

Outdoor power control enclosures consist of equipment enclosed in a weatherproof enclosure complete with an illuminated, walk-in aisle. This enclosure provides space for metal-clad switchgear, relay and control panels, battery racks, control switches, RTU's and other instrumentation. This equipment is designed to be installed outdoors and operate in all types of weather. Controls, instrumentation and relaying can be maintained without exposure to the elements.
1. Receiving

Each section of equipment is securely blocked and braced for shipment. All moving parts are secured. However, care should be taken when unloading and installing.

1.1. Identification and Inspection

Prior to unpacking, carefully inspect the equipment as soon as possible after receiving for any damage that may have occurred in transit.

Each project will be shipped with a project packing list describing the contents of the shipment. When the shipment consists of one complete section, the packing list will describe the equipment and any uninstalled or additional material that is packed inside. The packing list should be used to verify the equipment has been shipped in its entirety. If there is any shortage, make certain it is noted on the freight bill and contact the OPC Project Manager immediately.

When shipment consists of more than one shipping section or additional large material, each crate or package is marked with the OPC job number and shipping section number. The project packing list will identify the separate sections and the contents of each section. Refer to the plan view for the location of each unit within the assembled lineup. Use this information to simplify the assembly operation and save unnecessary handling.

After unpacking, examine equipment for any damage. Any obvious damage or visible signs of improper handling of the shipment should immediately be communicated to the OPC Project Manager and marked on the bill of lading. Include the type of object, part number and description of the damage.

1.2. Lifting and Handling Instructions

Each section of equipment has provisions for attaching lifting equipment to an overhead crane of adequate height and lifting capacity. Refer to the plan view drawing for the approximate section weights. Use adequate safety factors when unloading the equipment.

A detailed plan should be followed when unloading and placing equipment sections. The diagrams included in this manual are examples and may not represent every type of equipment. It is the responsibility of the user to determine the best method and procedures for unloading and placing the equipment, using this manual as a general guide and following standard industry practice. Refer to the specific plan view drawing for arrangement of equipment sections.

WARNING: The recommended method for lifting and moving OPC supplied equipment is by crane. If a crane cannot be used to move the equipment, refer to the following methods as a guide. Failure to do so may result in damage to equipment and void the warranty.
1.3. **Lifting Indoor Switchgear**

Indoor equipment is provided with lifting angles at the sides of the switchgear. The load angle on lifting cables must be at least 60 degrees to prevent damage to the equipment during lifting. (See Figure 1)

NOTE: Lifting angles supplied by OPC. Lifting cables and spreader bar (if applicable) are to be supplied by others. Cable type, size, length, and capacity are to be determined by others based on information provided by OPC with additional consideration for boom reach.

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**Figure 1: Lifting Indoor Switchgear**

4 Equal length cables connect to lifting angles with a clevis

60 degrees minimum

Connect to lifting hook on crane
1.4. Lifting Outdoor Aisle-Less Switchgear

Lifting lugs are provided on outdoor switchgear at each lower corner of a shipping section. Cables connecting lifting lugs to the spreader bar should be connected so that they are snug against the switchgear enclosure. Make sure the cables clear any outdoor mounted equipment and extended roof sections. Cables should be covered to protect the exterior finish. Cables are connected to the lifting brackets and spreader bar (supplied by others) using adequately sized clevis's. (See Figure 2)

Notes:
1. Load will need to be balanced by use of different lengths of cables due to weight variance.
2. Cables and spreader bar to be supplied by others.
3. Cover cables to protect the finish.
4. Connect cables to the spreader bar with a clevis.
5. Connect cables to lifting lugs with a clevis.
6. Cable and clevis type, size, length and capacity to be determined by others. Cables should be of sufficient rating to lift the OPC equipment.

NOTE: Lifting Lugs Supplied by OPC

Figure 2: Lifting Outdoor Aisle-less Switchgear
1.5. Lifting Outdoor Aisle-Type Switchgear / Power Control Enclosure

Lifting lugs are provided on the outdoor enclosure at each corner of a shipping section. Cables should be covered to protect the exterior finish. Cables are connected to the lifting lugs and spreader bar using an adequately sized clevis. This section applies to switchgear sections and switchgear shipped as one unit. (See Figure 3)

Notes:
1. Load will need to be balanced by use of different lengths of cables due to weight variance.
2. Cables and spreader bar to be supplied by others.
3. Cover cables to protect the finish.
4. Connect cables to the spreader bar with a clevis.
5. Connect cables to lifting lugs with a clevis.
6. Cable and clevis type, size, length and capacity to be determined by others. Cables should be of sufficient rating to lift the OPC equipment.

WARNING: It is extremely important that the correct size spreader bar be used. A spreader bar of inadequate strength will bend, causing possible damage to the switchgear and injury to personnel. The dimensions of the spreader bar should be determined from the width of the shipping section. The cables should be a safe distance from the section without allowing the section to sway. Be sure to consider all exterior components, such as fan shrouds, extended roof sections, etc. that may interfere with the lifting cables.
1.6. Moving Switchgear / Power Control Enclosure Without Crane

Within buildings or obstructed areas where a crane cannot be used, the equipment can be moved with skids, rollers, jacks, and other such devices as required. To prevent distortion of the cubicles, jacking should be done evenly. Place the jack at the bottom of the lifting angles on indoor switchgear and at the lifting lugs for outdoor switchgear. Refer to figures 4 and 5 for the correct jacking methods and figure 6 if using rollers. Figure 5 depicts outdoor switchgear with aisle but can also represent the OPC power control enclosure.

If rollers are used to move indoor switchgear, they must equal the width of the shipping section to be moved plus an additional length to extend past the shipping section. A sufficient number of rollers of equal height should be used in order to distribute the load evenly. Rollers need to span the entire width of the gear, be rigid and a minimum 3” in diameter.
2. Equipment Storage

SAFETY WARNING: THE FOLLOWING INSTRUCTIONS SUGGEST THE SWITCHGEAR SPACE HEATERS (IF EQUIPPED) BE ENERGIZED FROM AN ALTERNATE SOURCE DURING STORAGE. PLEASE BE AWARE THAT IF THE OPC EQUIPMENT CONTAINS A CONTROL POWER TRANSFORMER (CPT), AND/OR AN EXTERNAL CPT IS CONNECTED TO CIRCUITRY WITHIN THE OPC ENCLOSURE, IT MUST BE ISOLATED FROM THE SECONDARY (LOW) SIDE WHEN AN ALTERNATE POWER SOURCE IS APPLIED TO PREVENT DANGEROUS VOLTAGE ON THE CPT PRIMARY (HIGH) SIDE.

FOR OTHER EQUIPMENT, REFER TO PROJECT DRAWINGS SHOWING THE CPT DISCONNECT AND TAKE PROPER PRECAUTIONS BEFORE ENERGIZING ANY SECONDARY EQUIPMENT FROM AN ALTERNATE SOURCE.

If vacuum circuit breakers are shipped installed in the switchgear cubicles, follow the instructions for storage listed below. If the breakers are packed and shipped separate from the switchgear, they must be kept in the manufacturer's original packaging and stored in a clean, dry, and climate controlled location. In all cases, circuit breaker elements should be stored in accordance with the circuit breaker manufacturer's instructions.

Connect batteries (if provided) to a charger of sufficient rating. Charge the batteries per the battery and charger manufacturer's specifications. Batteries must be stored under the conditions listed in the “Battery Storage” (section 4). Batteries may be stored in a OPC sheltered aisle control building as long as battery manufacturer's storage conditions are met.

2.1. Indoor Switchgear

When indoor switchgear is not to be installed or placed into service immediately, it should be uncrated, inspected, and stored in a clean, dry and climate controlled location building; on a level surface. Indoor cubicles are not weatherproof. Do not set switchgear on or in direct contact with soil. If the storage area is located in an area of high humidity or subject to condensation, special care must be taken in order to keep the condensation from forming on the equipment. Energize the cubicle space heaters as this will help minimize moisture condensation from forming.

Consult the project drawings to locate the heater circuit(s) wiring and apply the proper control power.

Vacuum circuit breakers must be stored in accordance with the breaker manufacturer's instructions.

2.2. Outdoor Aisle-Less Switchgear

An outdoor aisle-less switchgear enclosure can be stored outside or indoors on a solid, level surface. Do not set switchgear on or in direct contact with soil. If at all possible, place the enclosure at the permanent location on the prepared foundation, even though it may be some time before the switchgear equipment is used.

When the enclosure is placed into its storage location, energize the space heaters. Consult the project drawings to locate the heater circuit(s) and apply the proper control power.

Vacuum circuit breakers must be stored in accordance with the breaker manufacturer's instructions.

2.3. Outdoor Aisle-Type Switchgear

An outdoor aisle-type switchgear enclosure can be stored outside or indoors on a solid, level surface. Do not set switchgear on or in direct contact with soil. If at all possible, place the enclosure at the permanent location on the prepared foundation, even though it may be some time before the switchgear equipment is used.

When the enclosure is placed into its storage location, energize the cubicle heaters. Consult the project drawings to locate the heater circuit(s) and apply the proper control power.

If the enclosure is equipped with an HVAC unit, and the unit was removed for shipping, install the unit in the proper location on the enclosure. Refer to the HVAC user’s manual for required preventative maintenance.
2.4. Outdoor Power Control Enclosure

An outdoor aisle-type power control enclosure can be stored outside or indoors on a solid, level surface. Do not set switchgear on or in direct contact with soil. If at all possible, place the enclosure at the permanent location on the prepared foundation, even though it may be some time before the power control equipment is used.

If the enclosure is equipped with an HVAC unit, and the unit was removed for shipping, install the unit in the proper location on the enclosure. Refer to the HVAC user’s manual for required preventative maintenance.

3. Battery Storage

SAFETY WARNING: BATTERY ACID IS CORROSIVE. IF BATTERY ACID COMES IN CONTACT WITH SKIN OR EYES, WASH THE AFFECTED AREA IMMEDIATELY WITH LARGE AMOUNTS OF WATER FOR AT LEAST 15 MINUTES. REMOVE CONTAMINATED CLOTHING IMMEDIATELY, INCLUDING SHOES. IF INHALED, EXIT AREA AND MOVE TO AN AREA WITH FRESH AIR. IF LEAD COMES IN CONTACT WITH SKIN, WASH THE AFFECTED AREA IMMEDIATELY WITH LARGE AMOUNTS OF SOAP AND WATER. IF LEAD COMES IN CONTACT WITH EYES, WASH AFFECTED AREA WITH LARGE AMOUNTS OF WATER FOR AT LEAST 15 MINUTES. IN ALL CASES LISTED ABOVE - SEEK IMMEDIATE MEDICAL ATTENTION.

It is the responsibility of the user to store and maintain batteries per local, state, and federal codes. If a spill containment system and/or neutralizing element are required for battery storage, it is the user’s responsibility to supply and install such equipment during storage. Consult the battery manufacturer’s instruction manual for specific information regarding storing or charging batteries.

After receiving batteries they must be inspected for any signs of damage or leaking fluid. The user should compare the contents of the shipment with the packing list to be certain that all items have been received before discarding any packaging.

Most batteries must be connected to a charger within ninety (90) days of shipment, or per the battery manufacturer’s instructions. Use a charger capable of charging the particular battery type and rating per the manufacturer’s instructions. Failure to properly charge the batteries could result in permanent damage to the battery cells. Wet cell lead-acid, gel-cell, and even valve regulated lead acid (VRLA) batteries may emit potentially explosive hydrogen gas. Batteries should be stored upright in a well-vented, temperature controlled area. The batteries should not be stored at temperatures below 50° F, and not above 100° F. Exposing batteries to high or low temperature extremes can dramatically reduce battery life. Follow the manufacturer’s instruction manual to keep each battery’s electrolyte at an appropriate level and for specific charging instructions that may differ from those listed above.

NOTE: Wash hands thoroughly with soap and water after handling batteries or working on the battery posts and connections.
4. Installation

The procedures listed below are a series of guidelines describing typical installations.

4.1. Outline of Installation Procedure for Indoor Switchgear

1. Prepare the equipment foundation.
2. Align the sections on the equipment foundation and bolt the sections together.
3. Level and anchor switchgear.
4. Remove all shipping braces.
5. Connect the ground bus across shipping splits (if applicable).
6. Install the primary bus across shipping splits (if applicable).
7. Reconnect wiring between shipping sections (if applicable).
8. Replace cover plates.

4.2. Details of Indoor Switchgear Installation Procedure

4.2.1. Prepare the Equipment Foundation

Sweep foundation clean of all debris. Clean the area where the equipment is to be installed and check to make sure the concrete, embedded channels etc are within manufacturers tolerance of +/− 1/8" level overall for proper installation.

4.2.2. Align the Sections on Foundation and Bolt Together

The plan view drawing will indicate the shipping sections and their location within the lineup.

Indoor switchgear shipping sections are held in true alignment by bolts holding the cubicles to each other. The entire lineup is to be anchored and leveled as a single element without loosening any hardware.

Refer to “Lifting and Handling Instructions” (section 2.2), and move first shipping section of switchgear to its final location.

When the first section of switchgear has been set in its final location, verify its alignment. It is important this section is in its proper alignment, as the alignment of any remaining sections will depend on it. If the lineup is shipped as one complete section, proceed to, “Level and Anchor Switchgear” (section 5.2.3). If the lineup consists of multiple sections, refer to “Lifting and Handling Instructions” (section 2.2) to move the next section in to position. Move the next section as close as possible to the fixed first section. Check shipping split end of each section for protruding wires and pull through as moving together. The front of the units should be in line and tight against the adjacent section.

Use moderate force to move the sections together with pry bars or cables. Cables of sufficient size and rating should be set near the bottom of the cubicles. Be sure to protect the surface of the cubicles from damage where the cables or pry bars make contact. A come-along ratcheting winch can be used to slowly bring the two sections together.

Align and install bolting. If shims are required, slide them under the switchgear cubicle near where the anchor bolts will be placed. Do not place shims under the middle of a cubicle section. See “Level and Anchoring Switchgear” (section 5.2.3).

At the shipping splits, bolt the switchgear sections together at the bolt locations shown in Figure 7. Hardware size is located in Figure 8. Start at the front top corner. The switchgear should be making contact with the foundation, either directly or with the installed shims. Do not force two sections together with the bolts, as this may cause damage to the cubicles or misalignment.
Figure 7: Indoor Switchgear Shipping Split Bolt Location (End View).

Figure 8: Assembly Hardware Sizes

- 3/8" x 1 ¼" Bolt
- 3/8" Lock Washer
- 3/8" Flat Washers
- 3/8" Nut
4.2.3. Level and Anchor Switchgear

Check cubicles at each anchor bolt location to make certain that they are in firm contact with floor or sill, whichever is used. If this condition does not exist, add 4" x 4" x 1/16" stainless steel shims adjacent to the anchor bolt location until firm contact is achieved.

Tighten anchor bolts per the anchor bolt manufacturer’s specification. Repeat for any additional sections. Check that the cubicles are in firm contact with the foundation or shims at each anchor point.

4.2.4. Remove All Shipping Braces

Examine all equipment and remove all marked shipping blocks or braces. These can include braces on fuse and potential transformer trunnions, temporary bus supports at shipping splits, door blocks and breaker clips (if breakers were shipped in cubicles).

4.2.5. Connect the Ground Bus Across Shipping Splits (If Applicable)

The ground bus in the switchgear is assembled in sections. A splice plate is supplied where the ground bus is split for shipping. Install this splice plate to connect each section of the ground bus. Wipe clean the surfaces of the ground bus joints before assembling. Use only a clean, lint-free cloth to remove any dust or debris from bus joints. Connect the ground bus to the substation or site ground grid per the overall station plan, if required. Ground bus connections may also be required in bus duct connections and bushing housings. Tighten ground bus connections to the correct torque using supplied hardware. Refer to Figure 24 and Table 1 for various bus size joints and hardware.

4.2.6. Install the Primary Bus Across Shipping Splits (If Applicable)

Refer to the project cubicle construction view drawings before installing the primary bus. Remove any cover plates or other components that may be necessary to install high voltage bus between shipping splits. Wipe clean the surfaces of the bus joints before assembling. Use only clean, lint-free cloth to clean bus joints. All bus bar insulation, post insulators, plastic barriers, and main bus supports should be free of dust and dirt particles and grease. Use de-natured alcohol if necessary for cleaning.

Splice plates, sections of bus and other hardware are supplied with the switchgear. The sections of bus removed at the shipping splits are labeled with the correct unit and phase. Slide the section of bus through the porcelain or epoxy supports in the side of the vertical section. Slide the rubber snubber along the bus until it fits inside the opening in the bus support.

Sandwich the end of the disconnected section between the splice plates on one side and fit the other end of the section between the splice plates on the end of the bus in the adjacent section. A riser bus will replace one splice plate. Line up the bus connections and place bolts through the splice plates on each end of the bus section. Align the bus bars and splice plates on the bolts before tightening. Refer to Figure 24 and Table 1 for various bus size joints and hardware. Repeat these steps for each section of bus at each shipping split.

4.2.7. Reconnect Wiring Between Shipping Sections

Route wires that were disconnected for shipping through wireway to adjacent unit terminal blocks and reconnect. Each wire is labeled. Connect cables going to remote locations. Refer to the “Secondary Control Wiring” (section 6.5) for connecting wiring at shipping splits.

4.2.8. Replace Cover Plates

Replace any other cover plates or other hardware that may have been removed for shipping or assembly.
4.3. Outline of Installation Procedure for Outdoor Switchgear

1. Prepare the equipment foundation.
2. Align the sections on the equipment foundation and bolt the sections together.
   A. Plan a sequence for placing additional equipment
   B. Sealing of joints
3. Level and anchor enclosure.
4. Remove all shipping braces.
5. Connect the ground bus between shipping sections (if applicable).
6. Install the primary bus between shipping sections (if applicable).
   Install additional exterior components.
   A. Medium voltage bus duct
   B. Medium voltage roof bushings
   C. HVAC, lighting, and other outdoor equipment.
7. Reconnect wiring between shipping sections (if applicable).
8. Replace cover plates.

4.4. Details of Outdoor Switchgear / Power Control Enclosure Installation Procedure

The following instructions apply to outdoor aisle-less, aisle-type switchgear and power control enclosures unless otherwise noted. Review these instructions completely before beginning installation.

CAUTION: The exterior of the enclosure must be properly sealed. Failing to do so may allow water to leak into the enclosure interior and possibly into medium voltage compartments. If the enclosure is not properly sealed, OPC cannot guarantee warranty coverage.

4.4.1. Prepare the Equipment Foundation

Sweep foundation clean of all debris. Clean the area where the equipment is to be installed and check to make sure the concrete, embedded channels etc are within manufacturers tolerance of +/- 1/8” level overall for proper installation.

Remove covers from secondary and primary openings in cubicl e floor plates. After the switchgear is in place the covers must be cut or punched to match the installed conduits.

4.4.2. Alight the Sections on the Foundation and Bolt Together

The proper installation method depends on whether the units are shipped as one complete assembly or in two or more sections. The plan view drawing will indicate the shipping sections and their location within the lineup. Refer to the “Lifting and Handling Instructions” (section 2.2) and move the first section into position as dimensioned on the plan view drawing. If the switchgear is a single complete shipping section, proceed to, “Plan a Sequence For Placing Additional Equipment” (section 5.4.3).

When the first section of switchgear has been set in its final location, verify its alignment. It is important that this section is in its proper position, as the alignment of the remaining sections will depend on it.

When the lineup consists of multiple sections refer to “Lifting and Handling Instructions” (section 2.2) to move the next section into position. Check the shipping split end of each section for protruding wires and pull through when moving together. The front of the units will be in line and tight against the adjacent section.

Before bolting the sections together, add a continuous ¼” bead of clear drying, silicone sealant (provided by OPC). The sealant should be added to the inside edge of one of the sections, about 1” from the outdoor-exposed edge of the section. Sealant should be added to each exterior portion of the switchgear as well as the roof section returns and headers above the switchgear cubicles. If additional sealant is required, use the same type and brand as supplied by OPC.

Figure 9 shows an example of two shipping sections of an outdoor switchgear enclosure with an aisle that are to be connected. Apply sealant on the exterior side of bolt holes on the walls and interior sides of the roof section bolt holes as shown in Detail A. Figure 10 shows the overall cross section of the shipping split with the areas that
require sealant. For sections that do not have switchgear cubicles, apply sealant to exterior side of bolt holes on all vertical walls and to the interior sides of the roof section bolt holes.

NOTE: Apply sealant to only one of the two shipping sections as described.

CAUTION: For fire-rated wall assemblies, be sure to use the FIRE-RATED silicone sealant supplied by OPC, in between the shipping wall sections instead of the silicone sealant, before bolting together. In case of a fire-rated assembly, the appropriate fire-rated sealant is supplied with the shipment. Add the sealant as shown in Detail A in between the firewall shipping sections. If more sealant is required, use the same brand and type as supplied by OPC. If this type is unavailable, use a fire-rated sealant with the following characteristics:

1. Meets ASTM E-814, UL 1479, and UL 2079 (or the latest versions of these codes for fire rated material)
2. Classified for sealing joints and penetrations in fire-rated walls and floors
3. Elastomeric

Figure 9: Connecting Shipping Sections

Connection Points

1/4" Bead of Water-Based Stretch Sealant

1" in from Exterior Edge

Detail A: Applying Sealant In Between Shipping Sections
With the section still elevated by the crane, ease the next section close to the other and set on pad. Be sure to protect the surface of the section from damage where the cables or pry bars make contact. A come-along ratcheting winch can be used to slowly bring the two sections together.

At the shipping splits, bolt the switchgear sections together when the sealant is still wet. Start with the base bolts first and work up. Bolts should be snug, but do not over tighten. See figure 12 for aisle-type switchgear bolt locations. (To gain access to some bolt holes, the floor cover plates need to be removed in the aisle) Aisle-type switchgear with insulated walls requires replacement of insulation and insulation barrier at shipping splits. See figure 13 for aisle-less switchgear bolt locations.

The various hardware types to be installed between the switchgear sections can be found in Figure 11. The specified hardware must be used when bolting the roof sections together. The rubber washers must be installed as shown in figure 11 and when mounting any devices on the outside of the switchgear. Remove any excess silicone from the seams after bolting is complete. Tighten bolts until snug without over tightening. Over tightening bolts could damage the hardware or the rubber washer seal.
Figure 12: Outdoor Aisle-type Switchgear Shipping Section Bolt Location (End View) See Figure 11 for bolting detail.

Bolt Holes
NOTE: These are only accessible if there is a cable entrance cover sheet at the rear cable entrance area. If the gear does not have this and is not sitting on piers, these bolts are not installed.

Base Bolt Holes
NOTE: Floor cover plates need to be removed in aisle to gain access to these.

Figure 13: Outdoor Aisle-less Switchgear Shipping Section Bolt Location (End View) See Figure 11 for bolting detail.
Add silicone sealant to exterior seams at shipping splits for weather proofing when bolting is completed. Exterior sealant is supplied by OPC. Exterior sealant should be applied to all exterior shipping split seams. Apply a $\frac{1}{4}$" bead of sealant and smooth the bead into the exterior joint seam. Add supplied sealant to the seam in between the switchgear cubicles and the roof return as well. Wipe off any excess sealant. (See Figure 14 and Detail B)

When additional sealant is required, use the same type and brand as supplied by OPC. This sealant should also be added to the exterior seams of a 2 hour rated firewall. Fire-rated sealant is not required on the enclosure exterior.

![Figure 14: Two Connected Shipping Sections](image)

![Detail B: Applying Sealant to Seam After Connecting the Shipping Sections](image)
Verify roof bolts are tightened securely, and all seams are sealed with silicone. Once silicone is dry, install roof cap. Hook the front of the roof cap to front of the switchgear and hook the other half of roof cap to the rear of the switchgear. Place peak roof cap over both ends of front and rear roof cap at the peak of roof and bolt together. Tighten bolts to a snug fit. Do not over-tighten. (See Figure 15)

Figure 15: Installing Roof Caps
4.4.3. Plan a Sequence for Placing Additional Equipment

When a transformer is part of the substation equipment the switchgear is typically positioned next to the transformer. Possible bus ducts are shown in Figure 16. Refer to the substation or overall site plan and elevation view drawings for placement of equipment. The user must plan the sequence of placing the transformer, switchgear and duct or throat sections to allow each unit to build on the previously placed equipment. This sequence will vary according to site conditions.

It is important that the first section be accurately positioned and leveled, as each subsequent section will depend on the first. Do not bolt switchgear and transformer throats together until leveling and anchoring operations are complete. Refer to “Install Additional Exterior Components” (section 5.4.6) for more information.

![Figure 16: Bus Duct Connections Between Transformer and Switchgear](image)
4.4.4. **Level and Anchor Enclosure**

The user is responsible for anchoring all OPC supplied equipment. Check the plan view drawing for positioning and anchor bolt locations of switchgear. Follow the instructions that are provided with the anchor bolts and hardware.

Check the immediate area at each anchor bolt location to make certain that channels supporting the switchgear are in firm contact with the foundation. If firm contact is not present in any anchor bolt location, 4” x 4” x 1/16” stainless steel shims should be inserted between foundation and bottom of channel until positive contact is achieved.

Refer to Figure 17 for suggested anchoring methods. The angles and plates shown should be finished with epoxy-based paint or galvanized to inhibit corrosion. If anchor angles are required, make sure to line up the angle with the base channel bolt hole locations. The base can also be drilled and tapped to allow for angles to be added. If the base is mild steel, make sure the provisions in the base are properly sealed with epoxy-based paint after installing the anchor angles, to inhibit corrosion.

Install anchor bolts. Add appropriate anchor hardware (washers, nuts, etc.) to anchor bolts. Tighten anchor bolts securely per the anchor manufacturer’s torque specification. Replace covers of secondary and primary openings in the deck plate of the OPC enclosure.

![Figure 17: Anchoring Outdoor Switchgear](image-url)
4.4.5. Remove All Shipping Braces

Examine all equipment and remove all shipping blocks or braces. These can include braces on fuse and potential transformer trunnions, temporary bus supports at shipping splits, door blocks and breaker clamps (if breakers were shipped in cubicles). There will be a breaker clamp on the bottom left side of the breaker front wheel for Eaton breakers. All other breakers are shipped outside of the cell. Do not remove any items that may be in question.

4.4.6. Install Additional Exterior Components (Bus Duct, Roof Bushings, HVAC and Lighting).

A. Medium Voltage Bus Duct

If OPC bus duct is supplied with one or more supports, shim as necessary with 4” x 4” x 1/16” stainless steel shims near the anchoring bolt locations. Anchor the support(s) with anchor bolts in the support foundation. The base of the support will have provisions for anchoring or provisions to add anchoring hardware.

In some cases OPC will furnish bus duct. Be sure to follow the bus duct manufacturer’s instructions on installing the duct and supports. The manufacturer’s supplied drawings should also indicate the anchoring techniques required for any bus supports.

When installing outdoor bus duct it is important that the duct enclosure is lined up properly with the switchgear. Each section will have bolt holes on the exterior of the duct for adding stainless steel hardware, supplied with the duct. Do not install hardware until the joints are made weather tight.

Wipe the mounting flanges (duct and switchgear) with a clean cloth to remove any dust or debris. After the flanges are dry add 1/8” x 1 1/4” adhesive urethane gasket material continuously around the perimeter of the switchgear incoming flange where the two flanges meet. It must make good contact with the flange and not have any gaps.
After the duct section is sealed to be weather tight it can be connected to the switchgear incoming flange. A crane of sufficient lifting capacity should be used to lift the bus duct into place. Use a nylon strap of sufficient capacity to lift the duct section. Lift the duct slowly into place per the plan view drawing.

The supplied mounting hardware will include bolts, nuts, washers, and lock washers. See Figure 19 or 19a for hardware placement.

Insert the bolts per Figure 19 or 19a. Tighten the hardware snug starting with the top bolts and working down. Do not over tighten, as this may damage the hardware and/or rubber washers. Inspect the joint to make sure there are no gaps. If any gaps are seen, run a ¼” bead of supplied silicone sealant over the gap, and smooth the sealant into the gap. The sealant is typically gray in color, but may be clear depending on the exterior enclosure color. Wipe off any excess silicone sealant. Install joint caps on top of the duct if provided. Refer to bus duct drawings for additional installation information.

Repeat the above procedures for lining up, sealing, and connecting any remaining sections of bus duct until the duct is installed. Follow these same procedures above for any duct that may meet the switchgear on the roof. Procedures for installing the bus inside the duct will be covered in “Electrical Connections” (section 6). When additional silicone sealant is required, use the same type and brand as supplied by OPC.
B. Roof Bushings

When the switchgear is equipped with roof bushings, the bushings and/or bushing tower were most likely removed before shipment. The bushing tower and bushings may have also been separated for shipment depending on the dimensions of this equipment. Refer to the plan view drawing for placement of the tower and bushings. Figure 20 shows typical bushing tower installations on the switchgear enclosure roof. The bushings are not shown.

![Figure 20: Bushing Towers](image)

To mount the tower, first prepare the area for installation. Remove any packing material or covers on the roof throat where the tower will be mounted. This may be a wood crate with plastic packing material or a piece of painted steel to keep out moisture. Wipe the mounting flanges (bushing tower and switchgear roof flanges) with a clean cloth to remove any dust or debris. Apply 1/8” x 1 ¼” adhesive urethane gasket material continuously around the switchgear incoming flange. The gasket must make good contact with the flange and not have any gaps.
After the tower is in place, install the bolts through each throat flange with the supplied stainless steel hardware. Add the hardware as indicated in Figure 19. Inspect the joint to make sure there are no gaps. If any gaps are seen, run a ¼" bead of clear silicone sealant over the gap, and smooth the sealant into the gap.

If the bushings were removed from the tower, they must also have a weather tight seal. Install the supplied gasket on the bottom edge of the bushing seat where it will meet the tower. Carefully lift the bushing, and set it into the mounting hole, bolt in place with provided hardware. NOTE: internal stud connector may need to be installed on bushing once it is lowered into tower bushing hole.

After the bushings are in place add a bead of OPC supplied silicone sealant where the outer edge of the bushing base meets the bushing tower on the exterior side.
C. HVAC, Lighting, and Other Outdoor Equipment.

When installing HVAC equipment, the joint where it meets the enclosure must be made weather tight. Most HVAC units will be the wall-mount type. Before lifting the HVAC unit into proper position, wipe the mounting bracket and the wall area that will make contact with the HVAC unit with a clean cloth to remove any dust or debris. Mount unit using hardware provided by OPC. See Figure 23.

Raise the HVAC unit into position. Line up the mounting holes into position and insert the supplied stainless steel bolts. Start at the top and work down when tightening bolts. The supplied hardware will have rubber washers. After the HVAC unit is bolted into place, run a ¼" bead of supplied silicone sealant around the top and sides, where the HVAC return flange meets the switchgear exterior skin. Silicone sealant is not required on the bottom side of the bottom installation bracket. See Figure 23 Front View for silicone sealing method.

To install additional equipment follow HVAC instructions.

After the external devices are all in place pull the wiring for these devices out through the opening or conduit that enters the enclosure. Connect the wiring as shown in the AC and/or DC miscellaneous drawings supplied with the project.

![Figure 23: Wall Mount HVAC Unit](image)
4.4.7. Connect the Ground Bus

The ground bus in the switchgear is assembled in sections. A splice plate is supplied where the ground bus is split for shipping. Install this splice plate to connect each section of the ground bus. If necessary, wipe clean the surfaces of the ground bus joints before assembling. Use only a clean, lint-free cloth to remove any dust or debris from bus joints. Connect the ground bus to the substation or site ground grid per the overall station plan. Ground bus connections may also be required in bus duct connections and bushing housings. Refer to the job specific drawings and the “Bus Bars” (section 6.1). Tighten ground bus connections to the correct torque using supplied hardware. Refer to Figure 24 and Table 1 for various bus size joints and hardware torque specifications.

4.4.8. Reconnect Wiring Between Shipping Sections

Route wires that were disconnected for shipping through wireway to adjacent unit terminal blocks and reconnect. Each wire is labeled. Connect cables going to remote locations. Refer to “Secondary Control Wiring” (section 6.5) for connecting wiring at shipping splits.

4.4.9. Replace Cover Plates

Replace any other cover plates or other hardware that may have been removed for shipping or assembly.

5. Electrical Connections

5.1. Bus Bars

Bolt all bus bar joints as follows:
1. All surfaces must be free of dust, dirt or other foreign material.
2. Assemble all joints as shown in figure 24.
3. Torque 1/2” Grade 5 bolts to 60 ft-lb. Refer to Figure 24 and Table 1 below for other common hardware torque specifications if SAE Grade 5 bolts are not supplied.
4. All bolts should be S.A.E. Grade 5. (Contact factory for torque required if non-standard bolts are used.)
5. Bolts to engage all nut threads and extend through nut.

![Figure 24: Bus Bar Joint Assembly](image)

<table>
<thead>
<tr>
<th>Bolt Size</th>
<th>Material</th>
<th>Torque (ft-lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2”</td>
<td>Stainless Steel</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Zinc Plated (Grade 5)</td>
<td>60</td>
</tr>
<tr>
<td>3/8”</td>
<td>Stainless Steel</td>
<td>18-20</td>
</tr>
<tr>
<td></td>
<td>Zinc Plated (Grade 5)</td>
<td>38</td>
</tr>
</tbody>
</table>

Table 1: Bus Hardware Torque Specifications
Notice in Figure 24, in the image labeled “STAINLESS HARDWARE”, a flat washer is used under the head of bolt and a Belleville washer under the nut. These washers ensure an evenly distributed force around each bolt, producing a low resistance joint. The torque value of approximately 43 ft-lb for ½-13 stainless steel bolts produce a joint of adequate pressure.

NOTE: All hardware furnished is plated high strength steel unless contract specifies otherwise. Bolts are ½-13 SAE Grade 5. Hexagon nuts are SAE Grade 5. Do not substitute with smaller or lesser grade hardware than supplied. If more hardware is required contact the OPC Project Engineer.

5.2. Bus Joints

Whether the switchgear is split into shipping sections or shipped as one complete unit, check all bus joints for proper torque values.

When a switchgear lineup is split for shipping purposes, the primary bus and ground bus connections must be made when installing the switchgear. These connections are relatively simple to make. However, refer to Figure 25 and notice the following:

1. If cleaning is necessary, use a clean, lint-free cloth.
2. Assemble all joints with the parts dry.
3. Refer to Figure 24 and Table 1 when tightening bus hardware. In most cases, the direction in which the bolt is inserted through the bus joint is important. Where insulation boots are used, put the nuts on the side with the deepest boot cavity. This normally would have the bolt heads toward the front of the cubicle. Install the hardware as shown in Figure 24 for the specific supplied type. Check all bus joints for proper hardware torque values.

Figure 25: Main Bus Bar Connection Configurations (Top Views)
Figure 26: Main Bus Joint Connection Configurations (Typical)
Rear View, rear doors, jamb, bus barriers, & surge arresters not shown
5.3. Insulation Boots

After bus bar connections are completed, install molded PVC insulation boots over bus bar joints as shown in Figure 27. Molded boots are secured with plastic pins after being placed over bus bar joints. Boots over bolted joints typically have a deeper cavity over the nut side of the joint hardware.

![Figure 27: Installing Molded Plastic Boot](image)

5.4. Bus Joint Insulation Tape

1. Apply one (1) half-lapped layer of 3M Brand #33 (or approved equal) over bare conductor and hardware.
2. Wrap joint with half-lapped layers of 3M Brand #130c EPR tape stretching to approximately 20% of its original width. Overlap the factory applied insulation approximately 2". Refer to Table 2 for taping layers per voltage class of equipment.
3. Wrap two (2) half-lapped layers of 3M Brand #33 jacketing tape over joint completely covering the EPR.

![Figure 28: Bus Joint Taping](image)

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Straight Bar NO. of Half-Lapped Layers</th>
<th>Bolted Connections NO. of Half-Lapped Layers</th>
</tr>
</thead>
<tbody>
<tr>
<td>600V</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5-8kV</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>15kV</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>25kV</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>35kV</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 2: 130C Tape Chart
5.5. Secondary Control Wiring

Inter-section wiring at shipping splits can be readily connected by referring to interconnect destination tags. Wires can be easily traced on a wiring diagram. Each device is illustrated and identified with a letter designation. A number identifies each terminal on each device.

Figure 29: Typical Hinged Panel Wiring Diagram
Figure 30: Typical Structure Wiring Diagram
5.6. POTENTIAL TRANSFORMERS

Trunnion mounted potential transformers are shipped mounted in the cubicle and blocked in position. Remove shipping straps at the front of the base and discard. Reconnect linkage strap at door. See Figure 31 for a standard trunnion.
Field Installation and Inspection Checklist  
(Install Performed by Others)

<table>
<thead>
<tr>
<th>Customer Name:</th>
<th>[ ] Done</th>
<th>[ ] N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Address:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPC Project Manager:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPC Job Order (Project) Number:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After preparation, unloading and re-assembly of the switchgear is completed by qualified field personnel, the following items are required to be inspected by the User (and/or User's Consultant) and the Lead Installation Technician. The installation must be performed in accordance with the supplied Omaha Power Center Installation **DO NOT perform the following checklist items on any energized equipment.** Any problems or deficiencies should be noted on this form. This form must be signed by both the User (or User's Consultant) and the Lead Installing Technician. If any problems or deficiencies are noticed during the install, keep a copy for your records and send the completed form to the OPC Project Manager. Contact the Project Manager immediately after discovering any problems or deficiencies. Any items requiring attention will be addressed by the Project Manager or Project Engineer and resolved.

1. Inspect re-assembly of shipping split sections to include the following:  
   a) Inspect shipping splits for tight seams. Verify that seams are sealed and weather proofed with silicone sealant.  
   b) Verify that bus joints at shipping splits are torqued and that boots are in place and attached with pushpins.  
   c) Inspect and verify main bus support rubber snubbers are in place and all main bus barriers are installed.  

2. Inspect reconnection of cubicle interconnect wiring, aisle wiring, conduits, and wireways at shipping splits and verify that all terminations are landed in their correct location.  

3. Verify that all termination points are tight at terminal blocks, relays, meters, test switches, field interconnects, etc.  

4. Inspect all medium voltage exterior bushings to assure no damage occurred in shipment.  

5. Check interior of cell, bottle assemblies, and overall project for cleanliness.  

6. Perform the following checks in accordance with the specific vacuum circuit breaker manufacturer's instructions. After breakers are uncrated and moved into their appropriate cell, the following checks will be made:  
   a) With the breaker in the withdrawn position and on the breaker rails, a visual check will be made to verify breakers have not sustained any damage due to shipping or mishandling.
<table>
<thead>
<tr>
<th>b) Move breaker into the cell, in most cases this will be the test/disconnect position. Verify that all breaker and cell code plates are in place and operate correctly.</th>
</tr>
</thead>
<tbody>
<tr>
<td>c) Crank breaker to the connect position and verify that breaker and shutter assemblies operate correctly. Verify that the position indicator operates.</td>
</tr>
<tr>
<td>d) Rack breaker out to the test/disconnect position. Verify that the position indicator operates.</td>
</tr>
<tr>
<td>e) If a Ground and Test Device was provided, verify proper operation by racking in to connect and back out to test/disconnect position.</td>
</tr>
</tbody>
</table>

7. Remove shipping blocks from PT and trunnions and install the door to cradle linkage rods. Check secondary contacts for proper alignment and contact wipe. Adjust when necessary.

8. If battery installation was provided, verify connection.

9. Match spare parts quantities to packing list, verify completeness.

10. Verify that all exterior doors and door linkage operate properly. Adjust when necessary.

Lead Installation Technician  
Date

User (Customer) or Consultant  
Date

Please note that by signing this form, you are acknowledging that the above tasks have been satisfactorily performed, deficiencies have been identified and the spare parts have all been identified in their respective locations as listed on the packing list. Keep this form for your records.