

Installation

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Introduction

Qualified Persons

WARNING

Only qualified persons knowledgeable in the installation, operation, and maintenance of overhead and underground electric distribution equipment, along with all associated hazards, may install, operate, and maintain the equipment covered by this publication. A qualified person is someone trained and competent in:

- The skills and techniques necessary to distinguish exposed live parts from nonlive parts of electrical equipment
- The skills and techniques necessary to determine the proper approach distances corresponding to the voltages to which the qualified person will be exposed
- The proper use of special precautionary techniques, personal protective equipment, insulated and shielding materials, and insulated tools for working on or near exposed energized parts of electrical equipment

These instructions are intended only for such qualified persons. They are not intended to be a substitute for adequate training and experience in safety procedures for this type of equipment.

Read This Instruction Sheet

NOTICE

Thoroughly and carefully read this instruction sheet and all materials included in the product's instruction handbook before installing or operating the S&C Custom Metal-Enclosed Switchgear - Arc-Resistant. Become familiar with the Safety Information on page 3 and Safety Precautions on page 4. The latest version of this publication is available online in PDF format at sandc.com/en/contact-us/product-literature/.

Retain This Instruction Sheet

This instruction sheet is a permanent part of the S&C Custom Metal-Enclosed Switchgear - Arc-Resistant. An assembly of S&C Custom Metal-Enclosed Switchgear may incorporate many types of components, such as interrupter switches, power fuses, switch operators, source-transfer controls, voltage sensors, current sensors, meters, etc., depending on user requirements. These components may be manufactured by S&C or by others. Operational instructions for each S&C-manufactured component are provided in separate S&C instruction sheets.

For each switchgear assembly, the applicable instruction sheets, drawings, and wiring diagrams are in an envelope entitled "Installation and Operation Information Kit." This envelope is located in a holder inside the appropriately marked switchgear-bay door. Instructions for components not manufactured by S&C are provided only when furnished by the original manufacturer.

Proper Application

WARNING

The equipment in this publication is only intended for a specific application. The application must be within the ratings furnished for the equipment. Ratings for the S&C Custom Metal-Enclosed Switchgear - Arc-Resistant are listed on each bay's nameplate.

Understanding Safety-Alert Messages

Several types of safety-alert messages may appear throughout this instruction sheet and on labels and tags attached to the product. Become familiar with these types of messages and the importance of these signal words:

⚠ DANGER
“DANGER” identifies the most serious and immediate hazards that will likely result in serious personal injury or death if instructions, including recommended precautions, are not followed.


⚠ WARNING
“WARNING” identifies hazards or unsafe practices that can result in serious personal injury or death if instructions, including recommended precautions, are not followed.

⚠ CAUTION
“CAUTION” identifies hazards or unsafe practices that can result in minor personal injury if instructions, including recommended precautions, are not followed.

NOTICE
“NOTICE” identifies important procedures or requirements that can result in product or property damage if instructions are not followed.

Following Safety Instructions

If any portion of this instruction sheet is unclear and assistance is needed, contact the nearest S&C Sales Office or S&C Authorized Distributor, or call the S&C Global Support and Monitoring Center at 1-888-762-1100. Telephone numbers are also listed on S&C’s website, sandc.com.

NOTICE	
Read this instruction sheet thoroughly and carefully before installing the S&C Custom Metal-Enclosed Switchgear - Arc-Resistant.	

Replacement Instructions and Labels

If additional copies of this instruction sheet are required, contact the nearest S&C Sales Office, or S&C Authorized Distributor, or S&C Headquarters, or S&C Electric Canada Ltd.

It is important any missing, damaged, or faded labels on the equipment be replaced immediately. Replacement labels are available by contacting the nearest S&C Sales Office or S&C Authorized Distributor, or S&C Headquarters, or S&C Electric Canada Ltd.

⚠ DANGER



S&C Custom Metal-Enclosed Switchgear - Arc-Resistant operate at high voltage. Failure to observe the precautions below will result in serious personal injury or death.

Some of these precautions may differ from your company's operating procedures and rules. Where a discrepancy exists, follow your company's operating procedures and rules.

1. **QUALIFIED PERSONS.** Access to S&C Custom Metal-Enclosed Switchgear must be restricted only to qualified persons. See the "Qualified Persons" section on page 2.
2. **SAFETY PROCEDURES.** Always follow safe operating procedures and rules.
3. **PERSONAL PROTECTIVE EQUIPMENT.** Always use suitable protective equipment, such as rubber gloves, rubber mats, hard hats, safety glasses, and flash clothing, in accordance with safe operating procedures and rules.
4. **SAFETY LABELS.** Do not remove or obscure any of the "DANGER," "WARNING," "CAUTION," or "NOTICE" labels.
5. **OPERATING MECHANISM AND BASE.** S&C Custom Metal-Enclosed Switchgear contain fast-moving parts that can severely injure fingers. Do not remove or disassemble operating mechanisms or remove access panels unless directed by S&C Electric Company.
6. **ENERGIZED COMPONENTS.** Always consider all parts live until de-energized, tested, and grounded. Voltage levels can be as high as the peak line-to-ground voltage last applied to the unit. Units that have been energized or installed near energized lines should be considered live until tested and grounded.
7. **GROUNDING.** S&C Custom Metal Enclosed Switchgear must be connected to a suitable earth ground at the base of the utility pole, or to a suitable building ground for testing, before energizing the switchgear, and at all times when energized.

The ground wire(s) must be bonded to the system neutral, if present. If the system neutral is not present, proper precautions must be taken to ensure the local earth ground, or building ground, cannot be severed or removed.
8. **SWITCH POSITION.** Always confirm the **Open/Close** position of each switch.
 - Switches and terminal pads may be energized from either side.
 - Switches and terminal pads may be energized with the switches in any position.
9. **MAINTAINING PROPER CLEARANCE.** Always maintain proper clearance from energized components.
10. **PADLOCKS.** Non-removable manual handles in high-voltage compartment doors and hinged-padlockable covers, as well as hinged-bolted panels, have provisions for padlocks that must be in place and secured at all times unless work is being performed inside the enclosure. Padlocks must be installed and secured on manual switch operating handles at all times unless the switch is being operated.
11. **SNAPLOCKS.** Snaplocks must be in place and the keys must be removed.
12. **KEY INTERLOCKS.** Key interlocks (if applicable) must be in place. Check the operating sequence of key interlocks to verify proper sequencing. After the switchgear is installed, destroy all duplicate keys or make them accessible only to authorized persons so the key interlock scheme will not be compromised. Key interlocks are not security locks.
13. **MECHANICAL CABLE INTERLOCKS.** Mechanical cable interlocks are provided to prevent access to fuses unless the switch is open and to prevent operation of stored-energy switch operators when the enclosure door is open. Do not attempt to operate any switch when the enclosure door is open. Periodically, verify these interlocks are functional. Refer to the instructions in the "Interlocks" section starting on page 37.
14. **EXCESSIVE FORCE.** Do not apply undue force to any handle when attempting to open or close a door or cover. The use of undue force may damage the handle or latching mechanism, or an interlock mechanism may be jammed. Do not attempt to close doors to reset interlocks. Instead, follow the instructions in the "Interlocks" section starting on page 37.
15. **PANELS AND SCREENS.** Make sure screens and hinged-bolted panels are bolted closed unless work is being performed inside the enclosure.
16. **FUSES.** Make certain fuses are disconnected from all power sources (including backfeed) before inspection or replacement.
17. **VOLTAGE TRANSFORMERS.** Disconnect all voltage transformers and voltage sensors when external voltage is used to test any secondary-side wiring or when heaters are energized for temporary storage. Do not disconnect voltage limiters from voltage sensors when the switchgear is energized.

Inspection

All assemblies of S&C Custom Metal-Enclosed Switchgear are fastened to wood skids for shipment as individual bays or multi-bay units. Certain items, such as fuse components, current sensors, surge arresters, key interlocks, etc., may be packed separately and, insofar as practicable, are shipped within the enclosure.

Examine the shipment for external evidence of damage. Check the bill of lading to make sure all listed shipping skids, crates, and containers are received.

If there is visible loss and/or damage:

1. Notify the delivering carrier immediately.
2. Ask for a carrier inspection.
3. Note condition of shipment on all copies of the delivery receipt.
4. File a claim with the carrier and notify S&C Electric Company.

If concealed damage is discovered:

1. Notify the delivering carrier within 15 days of receipt of shipment.
2. Ask for a carrier inspection.
3. File a claim with the carrier and notify S&C Electric Company.

Storage

S&C Custom Metal-Enclosed Switchgear should preferably be immediately installed in its permanent location. The space heaters for outdoor switchgear (and indoor switchgear, if so equipped) should be activated at once even though the switchgear itself may be energized later. See Figure 1. This is especially important for bays containing meters and relays, which are particularly susceptible to damage from moisture.

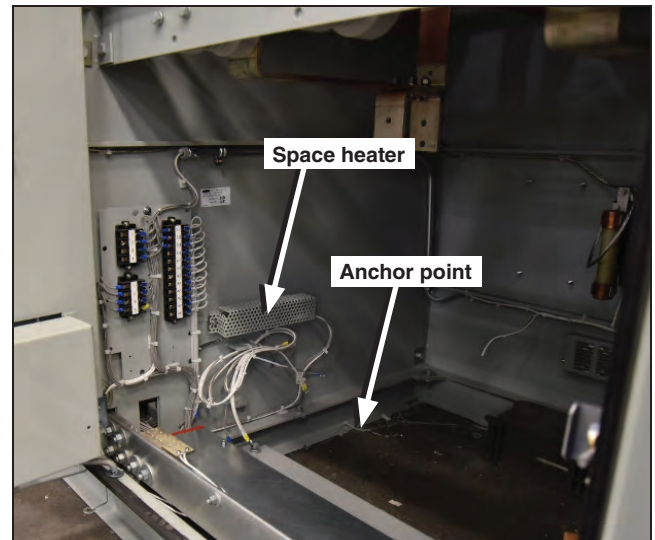


Figure 1. The space heater is behind a perforated sheath. Installation location of the anchor clips and nuts is also shown.

DANGER

If the space heaters are wired to be normally served through the secondary windings of voltage transformers located in the switchgear assembly, do not energize the space heaters from a temporary source until the following precautionary measures have been taken:

- Disconnect the secondary leads or remove the secondary fuses, and remove the primary fuses from the voltage transformers.
- If secondary connections are disconnected, tape the ends of the leads to prevent inadvertent short circuits or contact with the transformer secondary terminals.
- Connect the temporary source to the space heaters.

These precautionary measures must be taken to avoid energizing (backfeeding) the switchgear conductors at high voltage through the voltage transformers, which will result in serious injury or death.

When the switchgear cannot be immediately installed, storage in a clean, warm and dry room is recommended, especially for indoor switchgear. It should be protected from condensation, harmful gases, cement dust, and physical damage. If outdoor storage is a necessity, the following precautions should be taken:

Indoor Switchgear

If the switchgear was shipped with an outer protective wrapping, this covering should be removed. Shelter the switchgear with a tent-like covering, which will allow adequate ventilation but prevent entry of rain, snow, and contaminants through any openings. If the switchgear is not equipped with space heaters, install temporary electric heaters (250 to 500 watts per bay) to promote circulation to keep the interior dry.

Outdoor Switchgear

If the switchgear was shipped with an outer protective wrapping, this covering should be removed. Shelter the switchgear with a tent-like covering, which will allow adequate ventilation but prevent entry from rain, snow, and contaminants through any openings in the switchgear. If the switchgear is to be stored for a considerable time, connect and energize the space heaters to minimize condensation.

If the switchgear is to be stored, and it is impossible to connect and energize space heaters or temporary heaters, remove all meters, whether installed or separately boxed, and store the meters in a clean, dry room.

If the switchgear includes batteries, additional storage requirements apply. The battery charger should be disconnected from the battery, the battery should be charged periodically to avoid deep discharge that could damage the battery, and the battery should be charged for 24 hours following any extended storage.

Handling

Follow these steps to avoid damaging the gear when handling with an overhead hoist, and observe normal recommended procedures:

- STEP 1.** Arrange the lifting slings to distribute the lifting forces equally on all eyebolts. See Figure 2 on page 7.
- STEP 2.** Do not apply lifting force to any eyebolts at an angle less than 60° from the horizontal. See Detail A, Figure 2 on page 7.
- STEP 3.** If it is not possible to adhere to Step 2, wedge a timber between the eyebolts or slings as shown in Detail A, Figure 2 on page 7.
- STEP 4.** Be sure the eyebolts are screwed down to the shoulder before lifting the gear.
- STEP 5.** Avoid sudden starts and stops.

Note: It is not necessary to remove the eyebolts after the switchgear has been installed. If the eyebolts are removed, however, the holes must be plugged using galvanized bolts and washers, and sealing mastic.

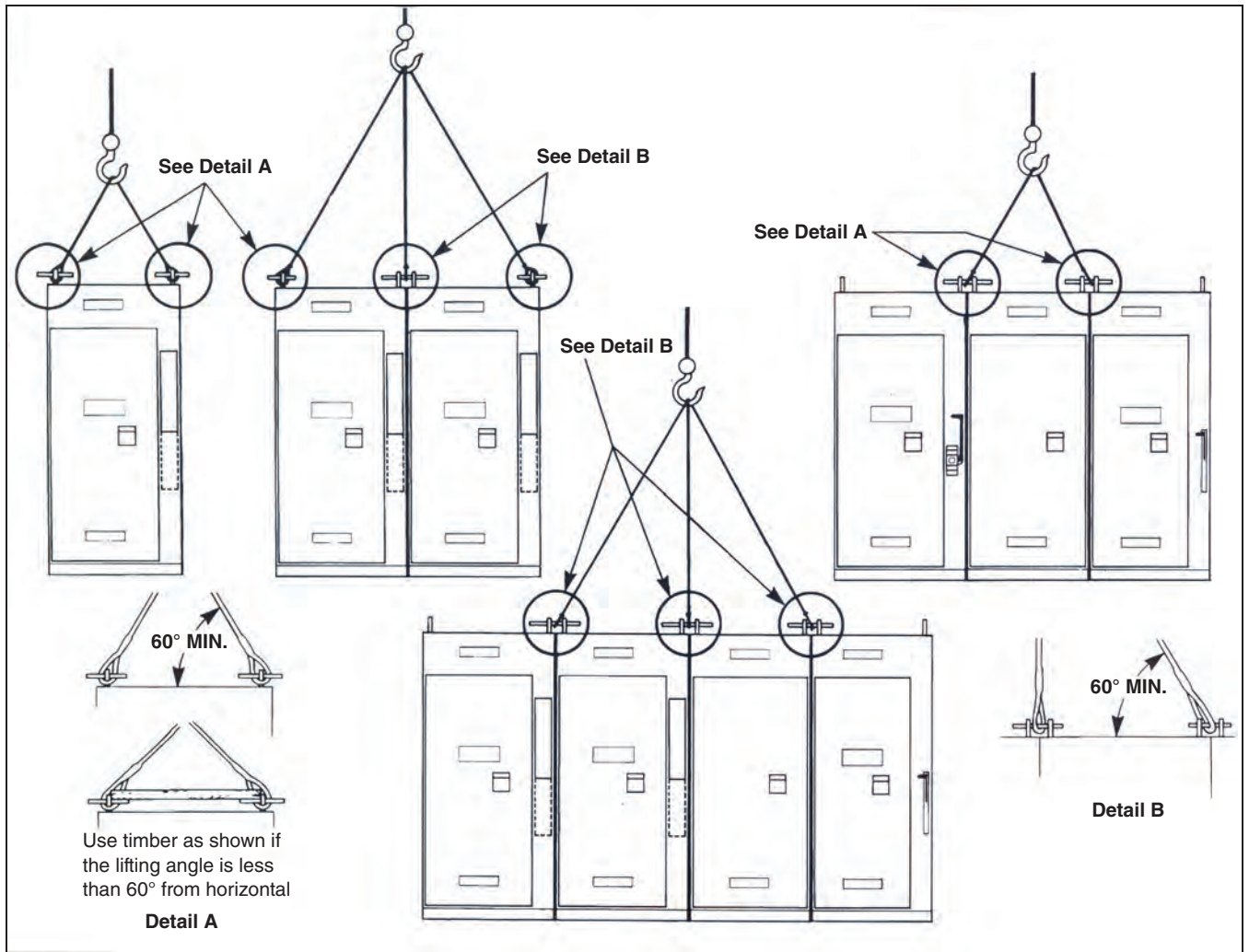


Figure 2. Hoist-sling arrangements and door-latching-mechanism references for S&C Custom Metal-Enclosed Switchgear.

Enclosure Security

S&C Custom Metal-Enclosed Switchgear incorporates many provisions to minimize hazards to qualified persons and to the general public. Each bay is fabricated from an 11-gauge steel sheet and is a free-standing, self-supporting unit with:

- **For switchgear installed in the United States:** An integral channel base of a thicker-gauge material than used for the enclosure and shall extend completely around all four sides of each bay
- **For switchgear installed in Canada:** Continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad

With this unitized design, there are always double walls between the adjoining bays. Externally removable side sheets, rear sheets, or roofs can be provided in rare situations to access components, if necessary. However, standard designs of S&C Custom Metal-Enclosed Switchgear are normally not provided with parts that can be removed externally. Even provisions for future bus extension are closed with a panel secured internally. Access is from the front only, through wide bulkhead-type doors having concealed cam-type, high-strength latches that seal the doors shut. Each full-length door has a minimum of three concealed, extra-heavy-duty hinges with stainless steel pins. All doors and covers are padlockable and have top and side flanges with double 90-degree bends (except hinged bolted panels), which overlap the door openings, adding rigidity and discouraging tampering.

Access Control

Switch operators and controls are isolated from high voltage in grounded, metal-enclosed compartments. Access to these components is controlled by padlockable covers, which incorporate a non-removable manual handle. Other low-voltage components, such as meters, selector switches, toggle switches, etc., are similarly isolated. Interlocks and padlocks help control access to high-voltage compartments.

For switchgear installed in the United States: Flush-mounted key-operated snap locks on doors and hinged-bolted panels providing access to high-voltage components.

A protective screen is furnished behind doors that provide access to high-voltage components. These screens, when bolted closed, serve as a second barrier to guard against inadvertent entry. Switch-operating handles are padlockable in the **Open** or **Closed** position. On outdoor style switchgear, baffles and screens mounted inside the enclosure cover all vents, discouraging wire poking.

Because this gear is often located in areas accessible to the general public as well as authorized but unqualified persons, care must be taken to alert such persons to the presence of high voltage within the enclosure. Therefore, do not remove any of the “Warning—Keep Out-High Voltage” or “Danger—High Voltage—Qualified Persons Only” signs attached to the gear. Any organization altering or removing these hazard altering signs must assume full responsibility for such actions.

Take particular care to make sure all screens and hinged-bolted panels are bolted closed and all doors, handles, and covers are securely padlocked before leaving the gear unattended, even momentarily.

WARNING

When optional key interlock schemes have been furnished, duplicate keys are provided for use during installation. To maintain the integrity of the key interlock scheme, the duplicate key must be destroyed or made accessible only to authorized persons. **Failure to do so can result in serious personal injury or death.**

Note: Key interlocks and snaplocks are not security locks and are not substitutes for padlocks.

Access to the interior of the switchgear bays can be obtained through three types of entrance ways: high-voltage compartment doors, hinged-bolted panels, or removable plates. See Figure 3 on page 10.

Opening Exterior Doors, Covers, and Panels

WARNING

Do not apply excessive force to any door handle when attempting to open a door. The use of excessive force may damage the door handle and latching mechanism, or an interlock may be jammed. Verify opening the door is in the sequence dictated by the interlock scheme provided. Trying to force open an interlocked door, or damaging the door mechanism, may make it difficult to secure the door of the switchgear. **This may lead to unauthorized entry into the gear that can cause serious personal injury or death.**

For switchgear installed in the United States:

Verify the snaplocks are unlocked and then verify opening the door is in the sequence dictated by the interlock scheme provided.

High-voltage compartment doors and hinged pad lockable covers use non-removable padlockable manual handles that pivot for door and cover opening. Most high-voltage compartment doors are secured closed by a three-point latching mechanism and may be equipped with a key-operated snaplock, key-operated interlock, and/or a mechanical cable interlock. If the bay includes fuses, a mechanical interlock or key interlock is provided, so the associated switch must be in the **Open** position before the door can be opened. Only operate switches when the associated door is closed.

To open the high-voltage compartment door or hinged, padlockable cover, remove the padlock from the hasp and firmly pull outward and downward on the handle. If the high-voltage compartment door is equipped with a self-latching door holder, pull the door open until it is secured in place by the holder.

Hinged bolted panels on switchgear bays or bus ducts may include captive bolts, key-operated snaplocks and provisions for padlocks. To open these panels, remove the padlock, disengage the snaplock, and then loosen all bolts.

Closing Exterior Doors, Covers, and Panels

High-voltage compartment doors and hinged padlockable covers are closed as follows: For doors, release the door holder if so equipped. Then, push the doors or covers so they are fully closed. While holding the door or cover closed, pivot the handle to engage the latches. Pull outward on the edge of the door (or cover) to verify it has latched securely. Insert a padlock into the hasp when the switchgear is energized.

Hinged bolted panels are closed by pushing the panel closed to engage the snaplock and then tightening all bolts securely. Verify the panel is fully closed and bolted. Insert a padlock into the hasp when the switchgear is energized.

Security Provisions



Figure 3. Two samples of switchgear showing the high-voltage compartment door, hinged padlockable cover, and hinged bolted panel.

Follow these steps to place the switchgear:

- STEP 1.** Transport the switchgear to the installation site observing the precautions given under the "Handling" section on page 6.
- STEP 2.** At the installation site, remove all separately packaged components shipped within the enclosure. Find the base plates and place them in the work area. Place the remaining components aside in a protected area.
- STEP 3.** Remove the CDA drawing from the waterproof envelope labeled "Installation and Operation Information Kit," and review the anchor-bolt plan.
- STEP 4.** From the anchor bolt plan, identify the bay or bay assembly to be installed closest to walls or structures. Because this bay or bay assembly will have the smallest working clearances, it should be installed first. (The bay numbers shown on the anchor-bolt plan correspond to the numbers on the front of the bays.)
- STEP 5.** Position the base plate for the bay or bay assembly to be installed first, as determined in Step 4, so the holes in the base plate match the anchor-bolt inserts in the mounting pad. (Each base plate is marked with the number of the bay that it matches.)
- STEP 6.** Prepare appropriate holes in the base plate where power and control cables are to enter the enclosure through a trench or conduit in the mounting pad.

If the bay or bay assembly is to be mounted over a cable vault or trench that communicates to an area where personnel could be present, install a conduit bushing with a cable adapter on each cable. See Figure 4.

⚠ WARNING
<p>Conduit bushings capable of sealing against 20 psig minimum must be installed on all cables entering bays or bay assemblies that communicate to an area where personnel could be present. Hot arc gases can enter the vault if these bushings are not installed. Failure to install conduit bushings may cause hot arc gases to enter the vault which can result in equipment damage, severe personal injury, or death.</p>

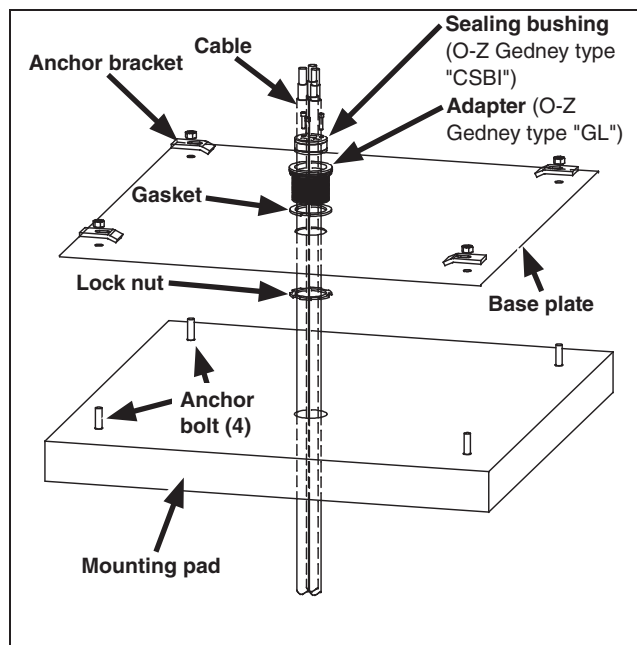


Figure 4. Cable with an adapter and bushing for entry through the mounting pad and base plate.

Placement

- STEP 7.** Unbolt the bay or bay assembly from its skid lift it and position it adjacent to its base plate, observing the precautions given in the “Handling” section on page 6.
- STEP 8.** Lay a continuous $\frac{3}{8}$ -inch (10-mm) bead of caulk around the perimeter of the base plate, about $\frac{3}{4}$ -inch (19 mm) from the outer edge, where the base of the bay or bay assembly will come into contact with it. See Figure 5. A room-temperature vulcanizing (RTV) silicone rubber compound is recommended. The RTV compound must not be allowed to set up before the bay or bay assembly is positioned on top of the base plate.
- STEP 9.** If excess lengths of direct-buried cable are to be fed into the bay or bay assembly as it is lowered, open the doors and latch the door holders to allow the excess lengths to be fed over the door stiles. If the interphase insulation barriers are removed to facilitate this procedure, note their positioning to ensure correct reinstallation later. It should not be necessary to remove any end barriers.

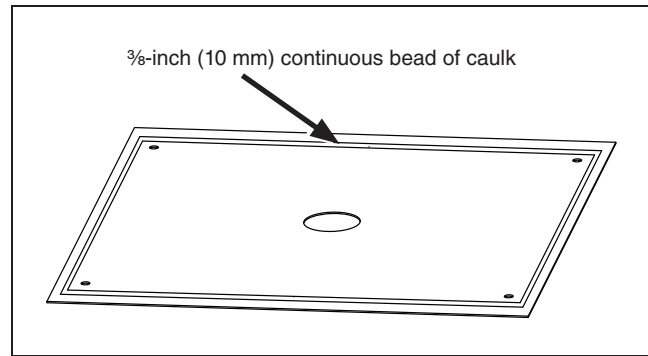


Figure 5. Base plate with caulking.

- STEP 10.** Begin lowering the bay or bay assembly while checking alignment as follows:
- Align the bay or bay assembly so the channel base is square with, and centered upon, the base plate. See Figure 6.
 - Where power and control cables are to enter the enclosure through a trench or conduit in the mounting pad, check these locations for alignment with the cable terminations provided in the switchgear.
 - When alignment is correct, lower the bay or bay assembly until it rests on the base plate squarely over the bead of caulk.
- STEP 11.** Use RTV compound to seal around all openings that have been made in the bottom of the enclosure for power and control cables.
- STEP 12.** Repeat Step 5 on page 11 through Step 11 for the remaining bays or bay assemblies.
- STEP 13.** *On indoor assemblies furnished with optional drip-proof or dust-proof construction and on outdoor multi-bay assemblies:* Obtain a weather-tight seal between units by applying adhesive-backed foam-gasket tape (provided) around exposed edges and roof section between adjoining units.
- On outdoor switchgear:* Two strips of gasket tape are used at the top of the enclosure. Strips of gasket at the top of the roof section should be installed the full depth of the enclosure with strips at side edges starting below the top strips. Remove any bus-opening support straps before applying the gasket.

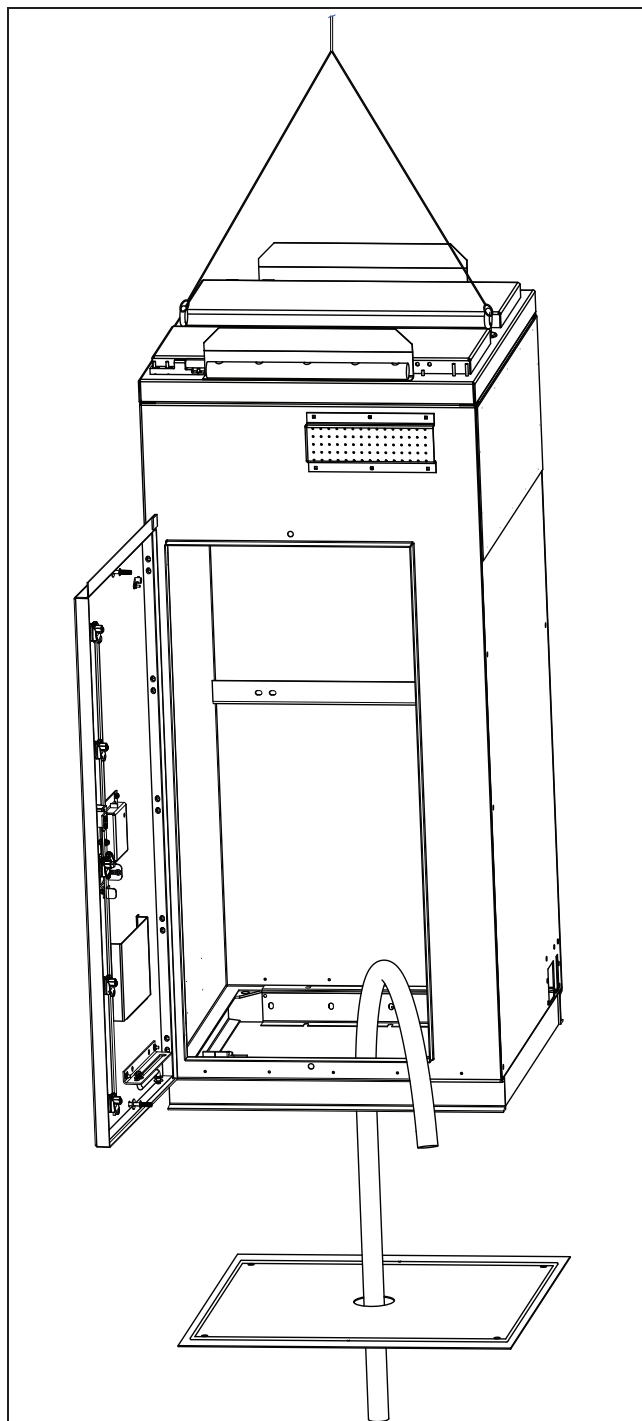


Figure 6. Aligning the bay for placement on the base plate.

Placement

STEP 14. Level the bay using metal shims as required. Secure each bay to the pad with the anchor clips provided by tightening the anchor-bolt nuts. See Figure 2 on page 7.

Make sure the switchgear-bay doors open and close without binding. Binding indicates enclosure distortion, which must be corrected by additional shimming.

Apply grout at the bottom of the enclosure to prevent entry of rodents, insects, or weeds. On outdoor assemblies, S&C recommends the grouting be recessed sufficiently from the exterior exposure to permit caulking with a weatherproof compound applied with a standard caulking gun. A room-temperature vulcanizing (RTV) silicone rubber compound is recommended.

On multi-bay assemblies shipped in individual units: Align, level, anchor, check door operation, grout, and caulk succeeding units in turn, and join units with the ½–13-inch galvanized bolts provided. The bolts may be easily pressed through the gasket tape. Do not attempt to draw misaligned units together with these bolts. See Figure 7.

Note: On multi-bay assemblies, avoid misalignment, which may result in improper operation of the switchgear and ineffective weather sealing between bays. Before installing the switchgear, determine where shimming will be necessary, and have the required shims on hand.

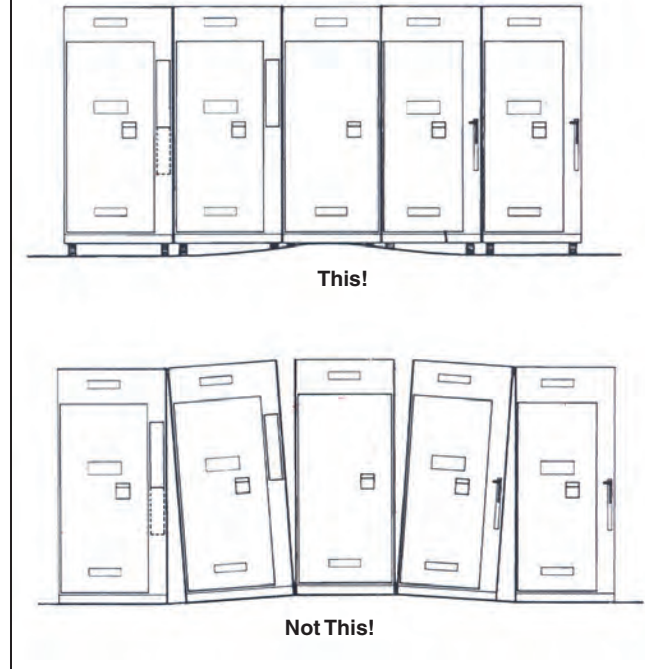


Figure 7. Alignment of multi-bay switchgear assemblies.

STEP 1. For Switchgear Rated 4.16 kV or 13.8 kV:

On outdoor switchgear (as well as indoor switchgear with optional dust-proof or drip-proof construction), after all bays are in place and bolted together, sides and top edges of through-bus openings between bays should have the supplied extruded rubber channel gasket installed.

- (a) To facilitate installation of the channel gasket, install and tighten bolts and nuts at the edges of the through-bus openings on adjacent bays using the $\frac{5}{16}$ -inch hardware provided. See Figure 8.
- (b) Stir the special adhesive provided until the color is the same throughout. Cement the channel gasket in place with the adhesive. Apply this adhesive evenly to the two sides and top of the bus opening flange in both bays, and to all inside surfaces of the channel gasket. After allowing the adhesive to become tacky (i.e. does not transfer to a knuckle when touched), start the channel gasket at the bottom front corner of the bus opening and, while verifying the gasket is seated completely over the opening flange, install the gasket at the front, top, and back of the bus opening.
- (c) Install gasket-support straps (provided) at locations along the top of each bus opening. Each end of the strap is to be placed against the nut on a roof-attachment bolt and secured in place with a $\frac{5}{16}$ -inch flat washer and a $\frac{5}{16}$ -inch locknut (provided). See Figure 9. Do not loosen any roof-attachment bolts.

For Switchgear Rated 25 kV or 34.5 kV: Install and tighten bolts and nuts at the edges of through-bus openings on adjacent bays using the $\frac{5}{16}$ -inch hardware furnished.

On outdoor switchgear: After all bays are in place and bolted together, install roof caps over roof flanges between bays and bolt them into place using the hardware furnished. See Figure 10 on page 16.



Figure 8. Bolt and nut location at the edges of the through-bus openings.

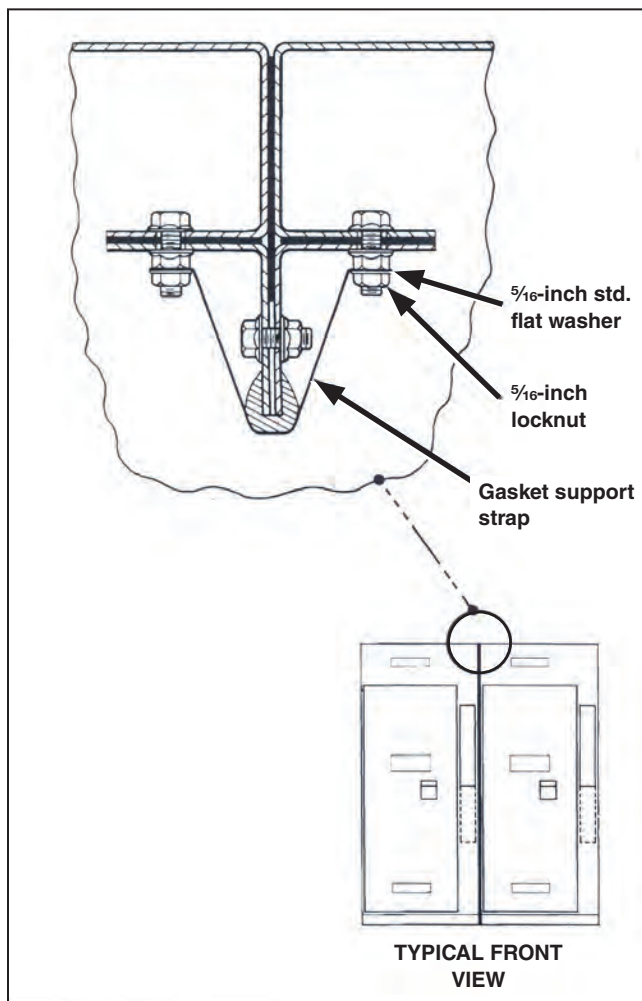


Figure 9. Installation of gasket-support straps in switchgear rated 4.16 kV or 13.8 kV.

Preparing for Service

STEP 2. Remove (where applicable) all barrier braces and switch-blade tie cords installed to restrain movement of these parts during shipping and handling.

NOTICE

To ensure adequate electrical clearances, splice plates and hardware must be installed in the manner described and illustrated in the following text and figures. Failure to comply with these instructions may reduce the BIL capability of the switchgear assembly.

For switchgear equipped with insulating through-bushings, semiconducting grommets must be installed on the bushings before installing splice plates. Failure to install grommets may cause corona discharge, resulting in loss of energy between the bus splice plates and the bushings and possible damage to the equipment.

STEP 3. The bus construction in S&C Custom Metal-Enclosed Switchgear is aluminum and copper. Terminal pads on components may be aluminum, copper, or copper alloy. Therefore, bus and terminal connections are typically aluminum-to-aluminum or aluminum-to-copper. These connections use Belleville (formed spring-steel) washers. Do not tighten factory-made connections using Belleville washers unless they are visibly loose because they have been correctly torqued to 50 foot-pounds at the factory.

Note: In cases involving copper bus construction or flexible laminated-copper connecting straps, copper-to-copper, copper-to-silver, or silver-to-silver connections may be found. These connections use flat stainless steel washers instead of Belleville washers (and stainless steel or Everdur hardware instead of galvanized hardware) and should be torqued to 35 foot-pounds because they may have loosened during shipment. Check bus connections and where necessary, and correctly tighten the connecting hardware.

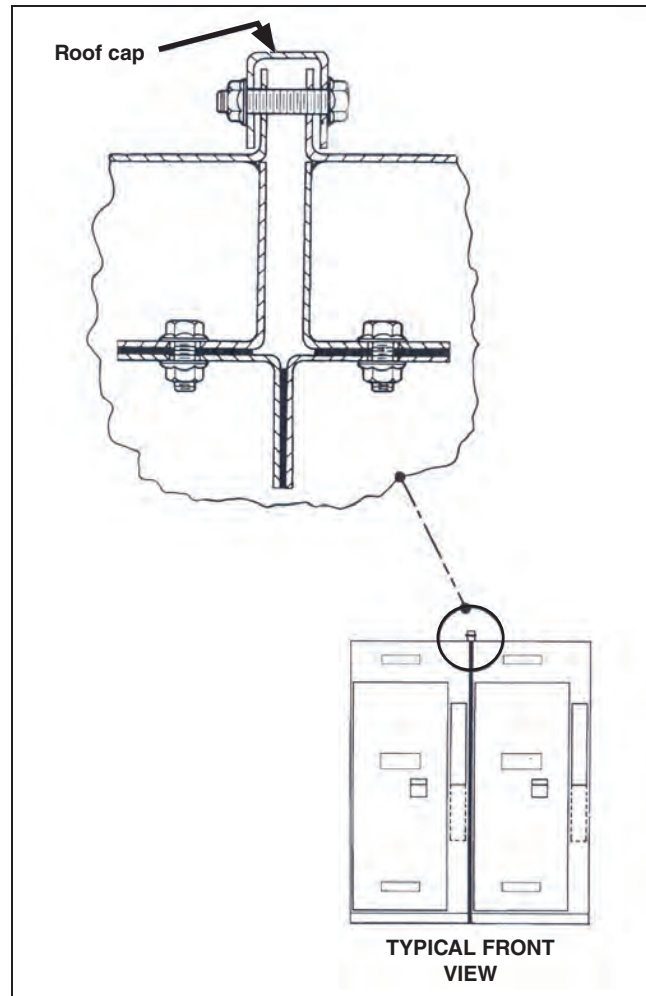


Figure 10. Installation roof caps over the roof flanges on outdoor switchgear rated 25 kV or 34.5 kV.

STEP 4. For the inter-unit splices in the main-bus and ground-bus runs, splice-plate kits have been provided. These kits contain splice plates, bolts, nuts, washers, a sheet of abrasive paper, a tube of anti-oxidant compound, and instructions.

For aluminum bus, both the bus ends and splice plates have been pre-abraded and coated with a thin layer of oxidation-inhibiting grease at the factory.

To ensure the highest quality joints, the mating surfaces of aluminum bus ends and splice plates should be re-abraded with the abrasive paper provided and immediately coated with a uniform layer of anti-oxidant compound just prior to making the bolted connections.

Note: For copper main bus and ground bus, joint surfaces may be silver-plated or tin-plated and require no corrosion-inhibiting compounds. Therefore, before joining, clean the surfaces with a clean dry cloth or, if necessary, with a mineral-spirits solvent. Do not use abrasives of any kind to attempt to remove discoloration that may appear on the silver-plated surfaces. This discoloration is characteristic of silver and does not affect the performance of the bus splice.

To facilitate installation of bus splices into through-bushings, lubricate the opening in the semiconducting grommets with one of the following lubricants: NYE Rheolube, Shell Gadus S2 U1000 2, petroleum jelly, liquid soap, or talcum powder. Make the bus splices, including those for optional insulating through-bushings, as follows:

- (a) ***For aluminum-to-aluminum bus connections:*** Place the splice plate on the bottom of the ends of main bus sections or on the side of the ground bus facing the interior of the bay. Make the connections using one Belleville washer under the head of each bolt and one Belleville washer under each nut. The bolts must be installed with the bolt head on the topside of the main bus. Belleville washers must be installed with the outer ring of the cup toward the bus. See Figure 11 on page 18 (Detail A). Tighten all splice bolts and nuts to a torque of 50 foot-pounds, as indicated by a torque wrench. If a torque wrench is not available, tighten until the Belleville washers are flat, and then loosen one-half turn.
- (b) ***For copper-to-copper bus connections (that include silver or tin-plated copper connections):*** Place the splice plate on the bottom of the ends of the main bus sections and on the side of the ground bus facing the interior of the bay. Make the connections using one stainless steel flat washer under the head of each bolt and one stainless steel flat washer plus one split lockwasher under each nut. The bolts must be installed with the bolt head on the topside of the main bus. See Detail B of Figure 11 on page 18. Tighten all splice bolts and nuts to a torque of 35 foot-pounds as indicated by a torque wrench. If a torque wrench is not available, tighten until the split lockwasher is flat.

Preparing for Service

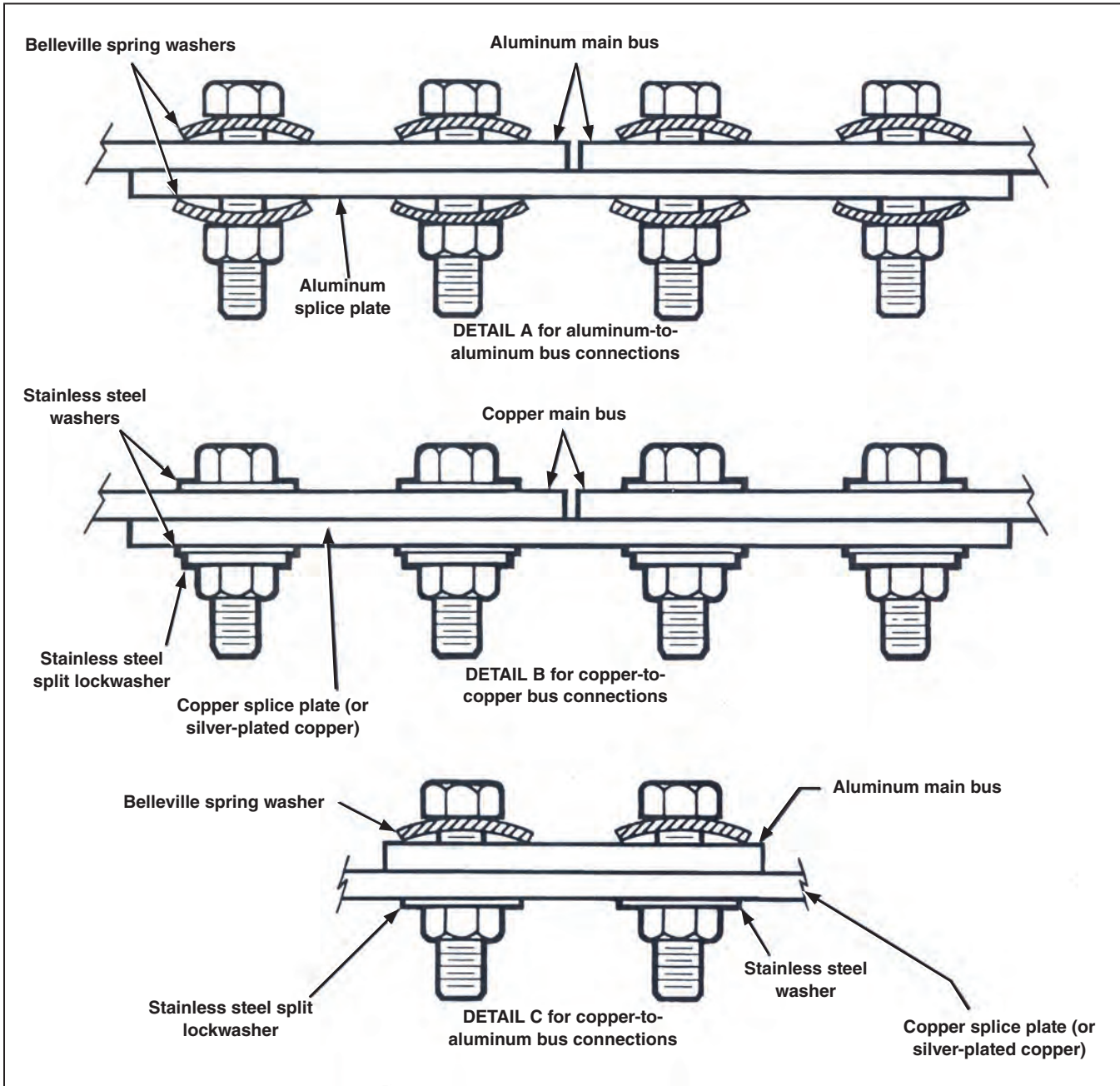


Figure 11. Installation of inter-unit bus splices.

(c) ***For copper-to-aluminum bus connections:*** Place the splice plate on the bottom of the ends of the main bus sections and on the side of the ground bus facing the interior of the bay. Make the connections using one stainless steel flat washer against the copper-bus section and one Belleville washer against the aluminum bus section. The bolts must be installed with the bolt head on the topside of the main bus. See Detail C of Figure 11 on page 18. Torque the bolts to 50 foot-pounds or, in the absence of a torque wrench, tighten each bolt until the Belleville washer is flat, and then loosen one-half turn. Do not use lock-washers with Belleville washers.

STEP 5. Make ground connections from the ground bus (or ground pad on a single-bay assembly) to the permanent station or system ground facility. S&C recommends cable not smaller than 1/0 copper, or equivalent, be used, and if the maximum momentary rating of the switchgear is to be realized, the equivalent of 500 kc mil of copper cable is required in either a single or multiple connection.

STEP 6. If secondary and control wiring are present, all terminals should be checked for tightness. Also, connect secondary and control wiring between adjacent bays at points where “shipping splits” occur. The individual wires at terminal blocks are marked to correspond with the adjacent terminal-block marking. Connection of the secondary and control wiring should be checked with reference to the applicable “CDR,” “QCDR,” or “CDT” wiring diagram included with the “Installation and Operation Information Kit.”

NOTICE

Remove all temporary jumpers connected across the current-transformer secondaries, and remove all shorting screws from the shorting-type terminal blocks. For feeder bays equipped with voltage sensors and Type SPD Open-Phase Detectors, shorting-type terminal blocks are also provided on the left-hand side wall of the high-voltage compartment. Store all shorting screws for future use in the holes provided in the terminal blocks.

Failure to remove the shorting screws will make every scheme relying on output from the current transformers or voltage sensors inoperative.

Preparing for Service

STEP 7. Remove all restraining tape and blocking from the movable elements of the meters and relays (if included) used to prevent movement of these parts during shipment, and check the elements for freedom of movement.

NOTICE

Relays are not set at the factory, so they must be adjusted to the proper settings.

WARNING

Switch operators and manual operating handles may be equipped with key and/or mechanical interlocks that guard against switch operation when the door of the bay containing the interrupter switch is open. Check the functional operation of mechanically interlocked doors and switch-operating mechanisms. Refer to the “Interlocks” section starting on page 37.

Failure to check and adjust interlocks may result in personal injury or death.

Key interlocks mounted externally and where the key is retained in the operated position are sometimes shipped separately to prevent key breakage during shipment. Install such interlocks with the bolts provided. The key sequence of the system is indicated on the one-line diagram on the “CDA/CDT” drawing. Where complex key interlock schemes are furnished, refer to the applicable “RD” or “CDT” drawing.

STEP 8. Fuse components (such as holders, fuse units, end fittings, interrupting modules, etc.) are crated separately. Assemble these components following the fusing procedure described in the instruction sheet packed with the applicable fuse components. Install the fuses in the fuse mountings following the procedures described in the S&C instruction sheet about operation that is included with the switchgear for the particular fuse type being used. When installing fuses, make certain complete fuse closure is attained. Store spare refill units, interrupting modules, or fuse units in the container mounted on the inside of the doors to the bays containing fuses or fused voltage transformers.

STEP 9. Check operation of manually operated switches. Separate instruction sheets on manually operated interrupter switches are included in the “Installation and Operation Information Kit” provided with the switchgear.

⚠ WARNING

To avoid personal injury or damage to interlocks, before operating any switches, close and latch the associated door and verify the switch operation is in the sequence dictated by the key- or mechanical-interlock scheme provided. Before proceeding with these instructions, refer to the “Interlocks” section starting on page 37.

If the switchgear is power operated, the switch operators and automatic control equipment may now be checked. Separate instruction sheets for the switch operator(s) and for the source-transfer control are included in the “Installation and Operation Information Kit” provided with the switchgear.

NOTICE

If high-voltage ac dielectric tests are to be performed on this switchgear or if preliminary operational tests using an auxiliary control-voltage source are to be performed before the switchgear is energized, special precautionary measures must be taken to prevent damage to certain switchgear components or inadvertent energization of the switchgear main bus. Refer to the “Testing” section starting on page 31.

STEP 10. After all other connections have been completed and checked, make the medium-voltage cable terminations by following the cable-terminator manufacturer’s instructions.

NOTICE

For switchgear equipped with a reverse-cable entrance or exit, the medium-voltage cable must be installed behind the reverse-cable bracket. These brackets are located inside the bay on the left side. Caution tags installed on the brackets are to be removed following installation of the cable. Failure to install the cable behind the bracket may result in reduced BIL rating for the switchgear.

Where field-assembled cable-terminating devices are used, terminations must incorporate adequate leakage distance between the exposed conductor and the stress-relief cone across a surface of nontracking material (or a surface rendered nontracking by properly taping with a suitable material).

To maintain the rated BIL capability of the switchgear, the following minimum clearances from energized parts (including unshielded portions of cable, such as terminator skirts) are required. See Table 1.

Table 1. Minimum Clearance for kV Rating

Rating, kV		Minimum Clearances	
Nominal	BIL	To Electrical Ground - Inches (mm)	To Insulating Barriers - Inches (mm)
4.8	60	3½ (89)	¾ (19)
7.2	75	4½ (114)	1 (25)
13.8	95	6 (152)	1½ (38)
25	125	8½ (216)	3 (76)
25	150	10½ (267)	3 (76)
34.5	150	10½ (267)	5 (127)
34.5	200	15 (381)	5 (127)

If necessary, interphase barriers can be removed to facilitate makeup and connection of cable terminations to the switch, fuse, or bus terminals. If the interphase insulating barriers are removed, note their position to ensure correct reinstallation later.

Following the user's established system operating safety procedures, check to make certain connection of the incoming-power source(s) to the switchgear terminals is in the proper phase sequence.

NOTICE

When making connections, care must be used to avoid placing intentional strain on any switch or fuse terminal. It is important each cable-terminator connector be flat against the corresponding switch or fuse terminal pad, with the bolt holes in alignment. Do not use the connecting bolts to pull the cables into alignment. **Failure to comply with these precautions may cause misalignment of the switch or fuse.**

STEP 11. Before connecting the cable terminators to the terminal pads, thoroughly wire-brush the aluminum contact surfaces to remove any dirt or foreign materials as well as the natural surface oxides. Immediately coat both contact surfaces to ½-inch (13 mm) beyond the joint with a uniform layer of anti-oxidant compound.

Note: Copper terminals have a thin layer of silver applied to contact surfaces, and the terminal surfaces must be prepared as described in the “Note” in Step 3 on page 16.

STEP 12. Make the connections as described in the following paragraphs (refer also to Figure 2 on page 7):

Note: Torque values apply only to the ½-inch hardware described and not to connectors used to secure primary leads of voltage transformers or surge arresters to the bus.

For aluminum terminal pads to aluminum connectors: Use ½-inch aluminum or galvanized steel hardware with two Belleville washers (not furnished), as shown in Detail A of Figure 12 on page 23. Torque aluminum bolts to the manufacturer's specifications. Torque steel bolts to 50 foot-pounds or, in the absence of a torque wrench, tighten each bolt until the Belleville washers are flat, and then loosen one-half turn. Do not use lockwashers with Belleville washers.

For aluminum terminal pads to tinned-copper or tinned-bronze connectors (untinned-copper or untinned-bronze connectors are not recommended): Use ½-inch galvanized steel hardware, with one Belleville spring washer (not furnished) against the aluminum terminal pad and one stainless steel flat washer against the tinned connector, as shown in Detail B of Figure 12 on page 23. Torque the bolt to 50 foot-pounds or, in the absence of a torque wrench, tighten the bolt until the Belleville washer is flat, and then loosen one-half turn. Do not use lockwashers with Belleville washers.

For copper terminal pads to tinned-copper or tinned-bronze connectors: Use ½-inch Everdur or stainless steel hardware, with one stainless steel washer against each terminal and one split lockwasher under the nut as shown in Detail C of Figure 12 on page 23. Torque the bolts to 35 foot-pounds or, in the absence of a torque wrench, tighten each bolt until the split lockwasher is flat.

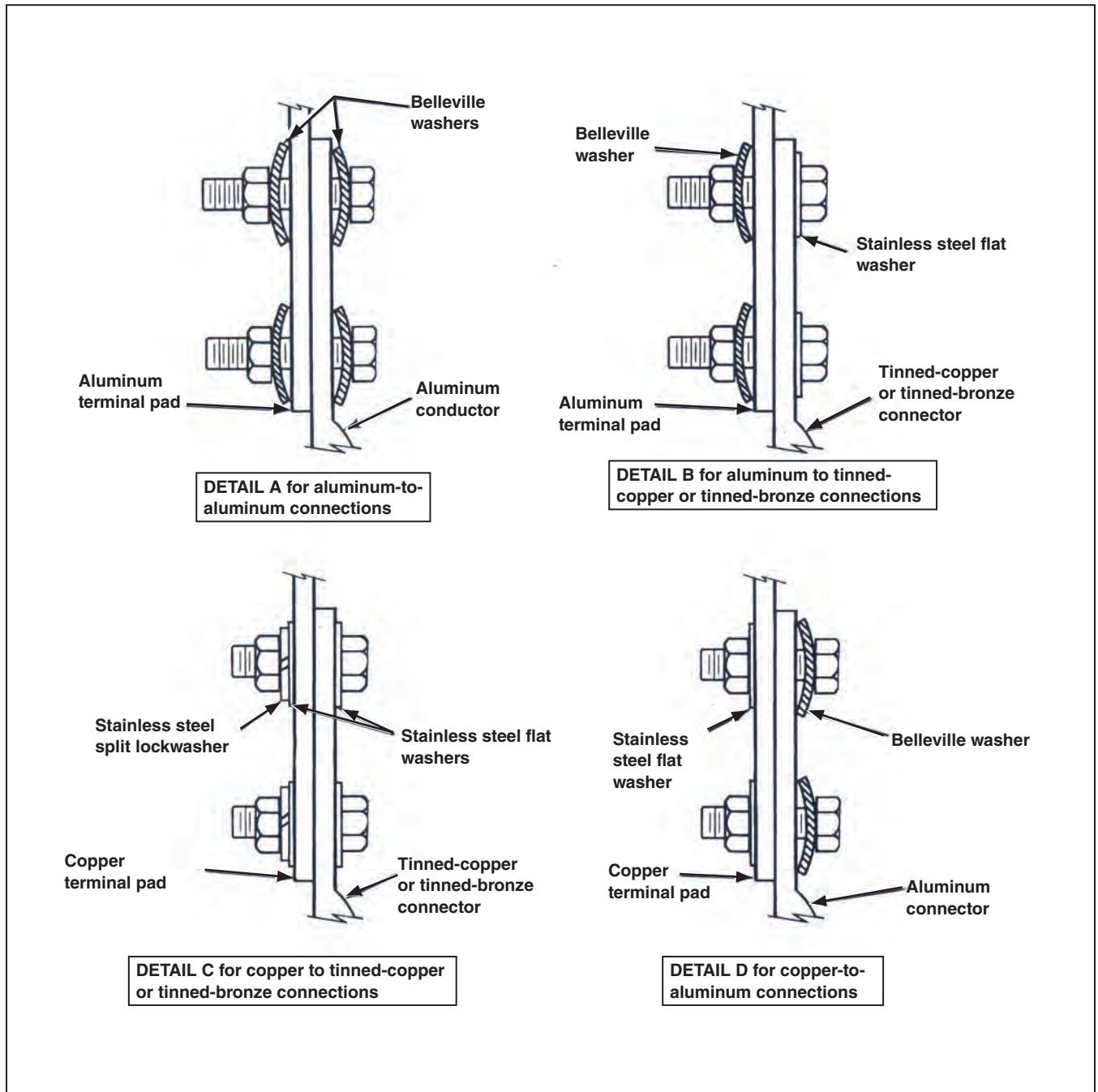


Figure 12. Terminal pad connections.

For copper terminal pads to aluminum connectors: Use ½-inch galvanized steel hardware with one Belleville spring washer (not furnished) against the aluminum connector and one stainless steel washer against the copper terminal pad as shown in Detail D of Figure 12 on page 23. If the Belleville washer extends beyond the edge of the aluminum connector, the positions of the Belleville washer and flat washer should be reversed, i.e., place the Belleville washer against the copper terminal pad and the flat washer against the aluminum connector. Torque the bolt to 50 foot-pounds or, in the absence of a torque wrench, tighten each bolt until the Belleville washer is flat, and then loosen one-half turn. Do not use lockwashers with Belleville washers.

NOTICE

After attaching the cable terminals to the terminal pads, to maintain the short-circuit rating of the switchgear assembly, secure the cable to the cable support bracket, which is provided in all bays containing Fault Fiter® Electronic Power Fuses and all bays where the available cable space exceeds 24 inches (61 cm) for 4.16 kV, 30 inches (76 cm) for 13.8 kV, 36 inches (91 cm) for 25 kV, or 48 inches (122 cm) for 34.5 kV. Under momentary conditions, mechanical stresses caused by unsecured cables may damage switches and fuses.

NOTICE

For correct functioning of the automatic control equipment, the current sensors must be placed either against the cable concentric-neutral ground wires (in which case the ground wires must be brought back through the current sensor before grounding as shown in (a) in Figure 13 on page 25 for S&C Closed-Gap Current Sensors) or against the cable semiconducting jacket (as shown in (b) in Figure 13 on page 25. Also, “drain-wire” type grounds on cable terminators, if present, must be brought back through the current sensor before grounding.

STEP 13. Switchgear may be equipped with S&C Closed-Gap Current Sensors, (see Figure 13) which can be used with the optional **Over-current-Lockout** feature furnished with S&C Micro-AT® Source-Transfer Control and with the optional Type ZSD Overcurrent Relay. These sensors are packed separately along with a supply of plastic tie wraps, connectors, and hardware. The control-wire leads to be connected to the current sensors are coiled and taped to the interior side wall of the appropriate enclosure.

Make the control wire-lead connections and install the current sensors following the procedures in the applicable instruction sheet and with reference to the applicable wiring diagram, all provided in the “Installation and Operation Information Kit” supplied with the switchgear.

STEP 14. Install and connect the surge arresters, if applicable.

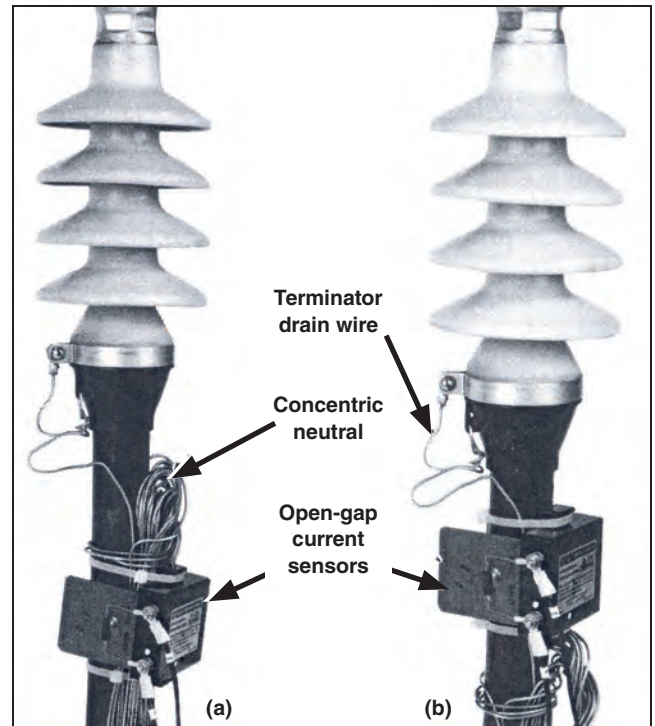


Figure 13. S&C Closed-Gap Current Sensors (included with the Overcurrent Lockout feature of the S&C Micro-AT Source-Transfer Controls and with the Type ZSD Overcurrent Relay) can be placed (a) against the cable grounded-concentric neutral or (b) against the cable semi-conducting jacket.

STEP 15. Space heaters are included as standard in all S&C Metal-Enclosed Switchgear designed for outdoor installation. They are also optionally available in indoor switchgear to maintain the enclosed apparatus and interior areas free of condensation, which, if allowed to accumulate, can contaminate insulation and promote corrosion. Therefore, when space heaters are included, make sure they are connected to an adequate power source and energized before placing the switchgear in service. See Figure 2 on page 7.

WARNING

If the space heaters are wired to be normally served through the secondary windings of voltage transformers located in the switchgear assembly, do not energize the space heaters from a temporary source until the following precautionary measures have been taken:

1. Disconnect the secondary leads or remove the secondary fuses, and remove the primary fuses from the voltage transformers.
2. If secondary connections are disconnected, tape the ends of the leads to prevent inadvertent short circuits or contact with the transformer secondary terminals.
3. Connect the temporary source to the space heaters.

These precautionary measures must be taken to avoid energizing (backfeeding) the switchgear conductors at high voltage through the voltage transformers, which could result in serious injury or death.

STEP 16. If any interphase insulating barriers were removed to facilitate accomplishment of the preceding steps, reinstall them at this time. Take care not to damage barriers on installation and make certain they are installed in the locations from which they were removed.

NOTICE

Make sure the clearances between barriers and energized parts conform to the minimum dimensions specified in Step 12 on page 22.

STEP 17. Sweep the enclosure floors free of debris. Wipe the barriers, insulators, bushings, terminators, switches, and fuses clean with a suitable mineral-spirits solution and dry with a clean dry cloth.

STEP 18. Check the functional operation of the key and mechanical interlocks, if furnished.

WARNING

To maintain the integrity of key interlock schemes, duplicate keys must be destroyed or made accessible only to authorized persons. If duplicated keys are made available after installation, it can increase the chances of using the key interlocks when they are not supposed to be used. **This can result in unwanted operation, which could result in serious injury or death.**

STEP 19. Remove all shipping tape, bay-number labels, and any polyethylene or tape from vents. Remove any remaining adhesive. Wipe down the exterior of the switchgear with a clean, damp cloth and, when thoroughly dry, touch up any scratches and abrasions using the touch-up primer and paint provided, observing the application instructions included on the aerosol cans.

STEP 20. Visually make sure all frangible fasteners securing the pressure relief flaps are in place and undamaged. See Figure 14.

NOTICE

Do not attempt to remove or change factory-set preload on the frangible bolts. Proper bolt tension can only be achieved by following specific instructions with a special tool.

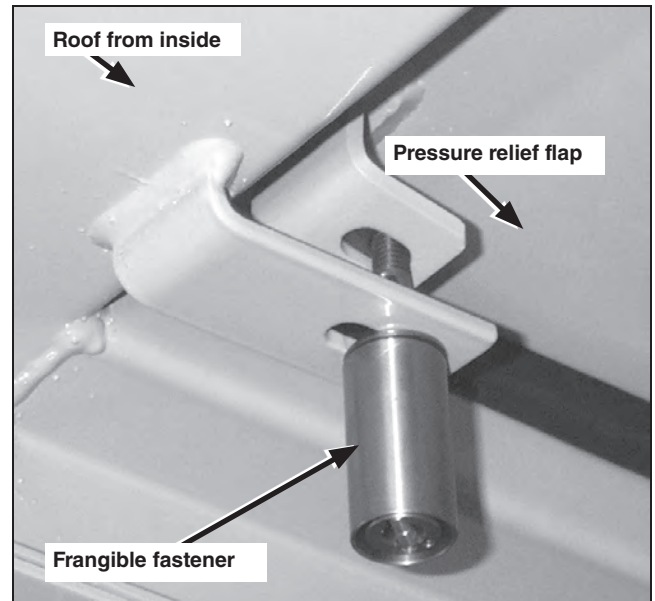


Figure 14. Frangible fasteners are factory-set for proper tension on pressure relief flaps.

Preparing for Service

STEP 21. Refer to the CDA drawing to view the clearance required for free movement of the pressure-relief flaps. The pressure-relief flaps must be free to move through a 90-degree arc. Refer to Figure 15 for the top-flap style and to Figure 16 for the side-flap style.

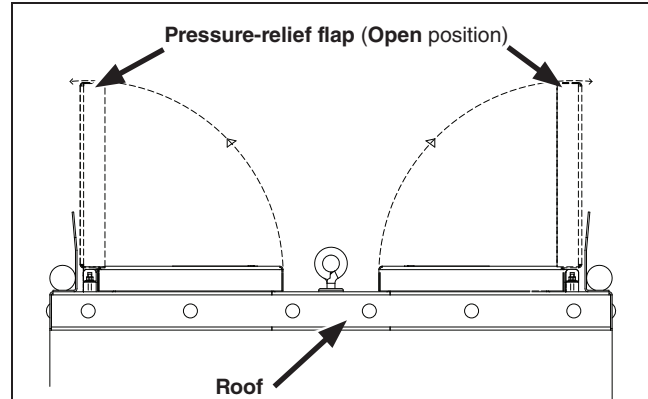


Figure 15. Top-flap style pressure-relief flaps are shown.

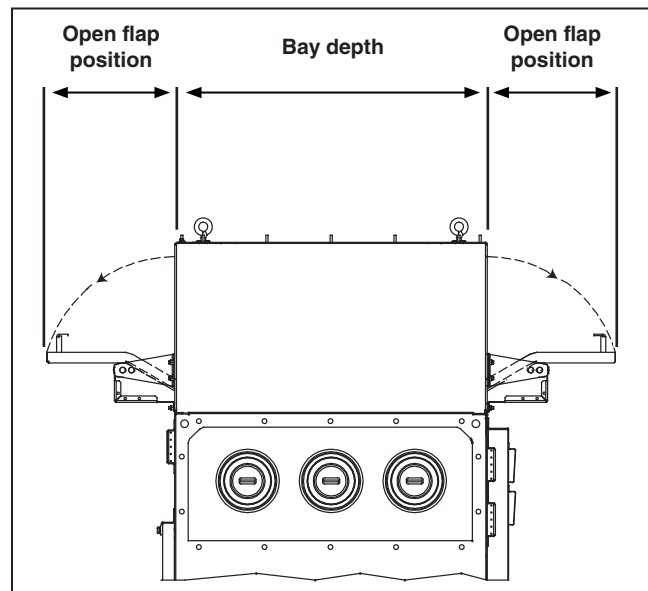


Figure 16. Side-flap style pressure-relief flaps are shown.

Additions to existing switchgear assemblies may easily be made if the original switchgear includes “provisions for future extension.” To minimize the outage time, proceed as follows depending on whether an inner protective barrier was furnished with the “provisions for future extension:”

Inner Protective Barrier Furnished

- STEP 1.** Remove the end plate from the existing bay by removing the appropriate hardware on the outside of the bay. This may be done while the equipment is still energized; an inner protective barrier behind the end plate prevents exposure to live parts. On outdoor assemblies, apply a gasket between the existing unit and the new unit. See Step 13 on page 13.
- STEP 2.** Move the new unit into place immediately adjacent to the existing end unit. Make the new unit “service ready” by completing all the bus and cable connections and other operations described in Step 1 on page 11 through Step 21 on page 28.
- STEP 3.** De-energize and properly ground the existing switchgear.
- STEP 4.** Remove the inner protective barrier from the inside of the existing end bay, and also remove the knockouts for the bolt holes and ground bus.
- STEP 5.** Bolt the units together. See Step 14 on page 14.
- STEP 6.** On outdoor switchgear (as well as indoor switchgear equipped with optional dust-proof or drip-proof construction), apply the rubber channel gasket (provided) to the through-bus opening between the units as applicable. For higher voltage units, install the roof cap. See Step 1 on page 15.
- STEP 7.** Install the inter-unit bus splices. See Step 4 on page 17.
- STEP 8.** Make certain all temporary grounds have been removed before re-energizing the switchgear.

Inner Protective Barrier Not Furnished

Follow these steps when the inner protective barrier is not furnished:

- STEP 1.** De-energize and properly ground the existing switchgear.
- STEP 2.** Remove the end plate from the existing bay by removing the appropriate hardware on the inside of the bay. Also, remove the knockouts for the ground bus and the bay-to-bay bolt holes. On outdoor assemblies, be sure to apply the gasket between the existing unit and the new unit. See Step 13 on page 13.
- STEP 3.** Move the new unit into place immediately adjacent to the existing end unit. Make the new unit “service ready” by completing all the bus and cable connections and other operations described in Step 1 on page 11 through Step 21 on page 28.

- STEP 4.** Bolt the units together. See Step 14 on page 14.

WARNING

To avoid equipment damage and possible serious personal injury, before walking away, perform the following checks:

1. Check the interior of each bay for foreign materials, tools, etc., that may have been mislaid on high-voltage bus and supporting members.
2. Make certain switch operators, if furnished, are coupled to interrupter switches.
3. Make certain all selector switches on source-transfer controls, if furnished, are in the desired positions.
4. Check all fuses to make certain they are fully closed and latched.
5. Close and securely latch all switchgear bay doors.
6. Make certain all interrupter switches are in the correct positions, **Open** or **Closed**, as dictated by electrical system design.
7. Make certain all grounding means have been removed.
8. Padlock all door handles, switch-operating handles, and covers (if applicable).

Additional instructions on correct positioning of specific components for normal operation are contained in the S&C instruction sheet for the specific component. Refer to the “Installation and Operation Information Kit” provided with the switchgear.

⚠ WARNING

The test procedures described in this document must be performed by qualified persons who are thoroughly experienced with this type of equipment and with the applicable codes and standards. See the “Qualified Persons” section on page 2 for more information. **Performing test procedures without adequate training and experience may lead to serious personal injury or death.**

Dielectric Testing**⚠ WARNING**

Before performing dielectric tests, make sure the high-voltage conductors are not connected (i.e., are de-energized and properly isolated). Test for voltage, and isolate and tag all circuits in accordance with established system-operating safety procedures. In addition, remove the primary fuses and disconnect all secondary connections from all voltage transformers and disconnect all surge arresters. **Failure to do so can result in personal injury or death.**

When high-voltage ac dielectric tests are to be performed on switchgear incorporating S&C Voltage Sensors, special precautions must be taken to prevent damage to the voltage sensor and the S&C Voltage Limiter. These precautions include the following:

- STEP 1.** Insert shorting screws into the shorting-type terminal block.
- Note:** An S&C Voltage Limiter is mounted on the left wall of the high-voltage compartment in applications involving S&C Source-Transfer Controls in entrance bays and in applications involving Type SPD Open-Phase Detectors in feeder bays. In the latter case, a shorting-type terminal block is furnished.

- STEP 2.** In applications involving S&C Source-Transfer Controls, remove the plug from the input receptacle located at the rear of the source-transfer control and transfer the plug to the control’s shorting receptacle; refer to the S&C instruction sheet on the source-transfer control furnished in the “Installation and Operation Information Kit.”

These precautions should also be followed when performing high-voltage dc dielectric tests, although application of rated dc dielectric test voltages will not damage the voltage sensors.

- STEP 3.** After all the dielectric tests have been completed, remove the shorting screws and transfer the plug from the shorting receptacle on the source-transfer control back to the input receptacle.

S&C recommends voltage-transformer primary fuses not be reinstalled—or secondary connections of unfused voltage transformers reconnected—until just prior to final energization of the switchgear for service. Remove all grounds and reconnect all high-voltage conductors and surge arresters.

Preliminary Operational Testing Before Switchgear Is Energized

If the switchgear is equipped with Micro-AT Source-Transfer Controls, S&C Type ZSD Overcurrent Relays, or S&C Type SPD Open-Phase Detectors, instructions for preliminary operational testing are contained in the S&C instruction sheets applicable to these devices.

The following test procedures apply only to switchgear equipped with S&C custom source-transfer controls with electromechanical components.

If it will be some time before high voltage is connected to the switchgear, the user may perform a preliminary checkout to expedite full service once high voltage is available. Operation of electromechanical source-transfer controls and switch operators may be checked using an auxiliary control-voltage source of the required voltage.

DANGER

The voltage transformers must be disconnected on the low-voltage side when external voltage is used to test ac-powered switch operators and source-transfer controls to avoid energizing the high-voltage conductors through the voltage transformers. **Failure to do so will result in serious injury or death.**

Follow these steps to perform the preliminary check:

- STEP 1.** Draw out the voltage transformers completely and disconnect all secondary connections if drawout-type transformers are provided. Otherwise, remove the primary fuses of the voltage transformers and disconnect the secondaries by removing the secondary fuses or by disconnecting the secondary connections to the transformers.
- STEP 2.** If secondary connections are disconnected, tape the ends of the leads to prevent inadvertent short circuits or contact with the transformer secondary terminals.

STEP 3. As a safety precaution, S&C recommends all voltage-transformer fuses be removed and kept out until just prior to final energization of the switchgear. With unfused voltage transformers, remove the secondary connections (as described in Step 1) until installation and any tests are completed.

STEP 4. If the switchgear assembly includes S&C Voltage Sensors used in conjunction with a custom source-transfer control, special precautionary measures must be taken. To avoid damage to the S&C Voltage Sensor's transformer because of inadvertent open-circuiting or removal of the burden, the voltage-sensor secondaries must be shorted at the shorting-type terminal blocks located in the switchgear bays.

- STEP 5.** When operational testing is completed:
- (a) Disconnect the auxiliary control-voltage source.
 - (b) Remove the shorting screws from the voltage-sensor secondary circuit and store the shorting screws for future use in the holes provided in the terminal block.
 - (c) Re-install the voltage-transformer secondary fuses and reconnect the secondary leads, where applicable.

S&C Metal-Enclosed Switchgear incorporates S&C's field-proven components for switching and protection of high-voltage power distribution circuits. These components, which are available in a variety of combinations to meet system requirements, are briefly described below. For complete instructions on these components, refer to the applicable S&C instruction sheets provided in the instruction manual furnished with each assembly of S&C Metal-Enclosed Switchgear. The following information is provided for preliminary familiarization with these components.

Interrupter Switches

Mini-Rupter® Switches

The Mini-Rupter Switch is a three-pole group operated interrupter switch. It is applied in S&C Custom Metal-Enclosed Switchgear for many of the switching duties associated with loads of up to 600 amperes at 4.16 kV and 13.8 kV, and up to 400 amperes at 25 kV. See S&C Instruction Sheet 785-501.

Mini-Rupter Switches with a quick-make quick-break mechanism integrally mounted on the switch frame are manually operated. Instructions on operation of these switches are contained in the S&C instruction sheets covering Mini-Rupter Switches.

Mini-Rupter Switches without a quick-make quick-break mechanism mounted on the switch frame are designed only for power operation by means of Type MS-2 or Type MS-10 Switch Operators. Instructions for operation of these switches are contained in the S&C instruction sheet covering Type MS-2 Switch Operators and Type MS-10 Switch Operators, as applicable.

Alduti-Rupter® Switches

The Alduti-Rupter Switch is a three-pole group operated interrupter switch. It is applied in S&C Custom Metal-Enclosed Switchgear for the heavier switching duties commonly encountered on larger systems—those duties associated with loads ranging as high as 1200 amperes at 4.16 kV, 13.8 kV, and 34.5 kV, and 600 amperes at 25 kV. See S&C Instruction Sheet 783-501.

The Alduti-Rupter Switch may be manually operated, or power-operated by means of an Type AS-30 Switch Operator. Instructions for operation of these switches are contained in the S&C instruction sheets covering Alduti-Rupter Switches and, if power-operated, Type AS-30 Switch Operators.

Fuses

S&C Types SM-4Z, SM-5S, SM-5SS, SM-20, and SM-40 Power Fuses or Fault Fiter® Electronic Fuses are applied in S&C Custom Metal-Enclosed Switchgear in combination with an S&C Interrupter Switch. Each S&C fuse is equipped with a blown-fuse target, permitting positive visual check of the fuse condition without removing the fuse from the mounting.

For instructions on how to install and replace fuses, and on how to detect a blown fuse, refer to the "Operation" instruction sheet for the fuse type furnished.

For instructions on installation and replacement of refill units, fuse units, or interrupting modules, refer to the S&C instruction sheet included with each Type SM Refill Unit, Type SMU-20® Fuse Unit, Type SMU-40® Fuse Unit, or Fault Fiter fuse interrupting module respectively and as applicable.

Switch Operators

Type AS-30 Switch Operators

The Type AS-30 Switch Operator is designed for power operation of Alduti-Rupter Switches, which include a quick-make quick-break mechanism integrally mounted on the switch frame. This switch operator provides live switching in response to supervisory control; circuit interruption for open-phase detection schemes; and automatic switching on primary-selective systems. See S&C Instruction Sheet 629-500.

In S&C Custom Metal-Enclosed Switchgear, these switch operators are located in grounded compartments isolated from high voltage and are chain coupled to the interrupter switches. They charge the quick-make quick-break mechanism (located on the switch frame) to open or close the switches with the torque and speed required to achieve interrupting and duty-cycle fault closing ratings.

Instructions on operation of these switch operators are contained in the S&C instruction sheet for Type AS-30 Switch Operators.

Type MS-2 Switch Operators

The Type MS-2 Switch Operator, for power operation of switch-operator-driven style Mini-Rupter Switches, provides high-speed live switching in response to supervisory control, circuit interruption for open-phase detection schemes, and high-speed source transfer for critical loads. In S&C Custom Metal-Enclosed Switchgear, the MS-2 Switch Operator is drawout-carriage mounted on a roller-track mechanism within a grounded, steel-enclosed, low-voltage compartment in the switchgear-bay stile—isolated from high voltage. See S&C Instruction Sheet 629-510.

This switch operator is connected to the Mini-Rupter Switch by a drive-linkage assembly. The MS-2 operator provides for both automatic trip-open and trip-closed operation. It incorporates a motor-charged quick-make quick-break stored-energy mechanism which, when solenoid tripped in response to a control signal or when manually tripped, opens and closes the Mini-Rupter Switch swiftly and positively, thus contributing to the Mini-Rupter Switch's ability to achieve fast circuit interruption and two-time duty-cycle fault-closing ratings.

Instructions on operation of these switch operators are contained in the S&C instruction sheet for Type MS-2 Switch Operators.

Type MS-10 Switch Operators

The Type MS-10 Switch Operator, for power operation of switch-operator-driven style Mini-Rupter Switches, provides high-speed live switching in response to supervisory control and circuit interruption for open phase detection schemes.

In S&C Custom Metal-Enclosed Switchgear, the MS-10 Switch Operator is a non-drawout type and is integrally mounted in the switchgear-bay stile. This switch operator is connected to the Mini-Rupter Switch by means of a drive-linkage assembly. See S&C Instruction Sheet 629-520.

The MS-10 operator provides for automatic trip-open operation. It incorporates a manually charged quick-make quick-break stored-energy mechanism which, when solenoid tripped in response to a control signal or when manually tripped, opens the Mini-Rupter Switch. Manual charging of the stored energy mechanism for opening or closing the switch is performed using a removable manual operating handle. Instructions on operation of these switch operators are contained in the S&C instruction sheet for Type MS-10 Switch Operators.

Source-Transfer Controls

S&C Source-Transfer Controls are used in S&C Custom Metal-Enclosed Switchgear, in conjunction with S&C Interrupter Switches driven by the Type MS-2 or Type AS-30 Switch Operators, to provide for automatic source transfer for primary-selective systems. Monitoring inputs for the source-transfer controls are typically supplied from each source by two S&C Voltage Sensors and one voltage transformer; in certain applications two or three voltage transformers may be used.

Micro-AT Source-Transfer Controls

The Micro-AT controls use an advanced electronic micro-processor to perform control operations, as directed by settings programmed into the device at the factory and in the field. See S&C Instruction Sheet 515-500.

These settings, which consist of the source-transfer controls operating characteristics and voltage-, current-, and time-related operating parameters are entered into the control by means of a keypad on the front panel of the control. To simplify review of the settings, the Micro-AT controls include a liquid-crystal display (LCD).

The event log captures system status, control status, and operating conditions for past control operations, providing the Micro-AT control with a built-in diagnostic capability.

In S&C switchgear, the Micro-AT control is secured to the bay stile in a grounded, steel-enclosed low-voltage compartment, and is removable for access. Instructions on operation and programming of settings for this control are contained in the Micro-AT Source-Transfer Controls instruction sheet.

Custom Source-Transfer Controls

Custom source-transfer controls with electromechanical components are used in S&C Custom Metal-Enclosed Switchgear in conjunction with S&C Interrupter Switches driven by the Type MS-2 or Type AS-30 Switch Operators, to provide automatic source transfer of complex primary-selective systems, as well as other customized automatic switching schemes.

In S&C Custom Metal-Enclosed Switchgear, custom source-transfer controls may be mounted on a swing-out panel within a grounded compartment isolated from high voltage. Custom source-transfer controls are used in switchgear configured for common-bus and split-bus primary-selective systems, monitoring source conditions and initiating switching operations.

Custom source-transfer controls are typically used to provide automation for systems served by more than two power sources, or involving other complex automatic switching operations. For switchgear equipped with a custom source-transfer control, an "Operation Description" section is included in the "Installation and Operation Information Kit."

Overcurrent Relays

The Type ZSD Overcurrent Relay is used in S&C Custom Metal-Enclosed Switchgear, primarily in conjunction with Type MS-10 Switch Operators in load feeder bays, to achieve three-phase isolation of the feeder circuit after a downstream fault has been cleared by the feeder fuses or the source-side protective device. Therefore, the ZSD relay responds to single-phasing conditions occurring downstream of the closed-gap current sensors, which are furnished and provide sensing for the relay. See S&C Instruction Sheet 551-500.

The ZSD is a solid-state electronic design. Control voltage for this relay is typically supplied by the switch operator's power source. Instructions on operation and adjustment of these relays are contained in the S&C instruction sheet for Type ZSD Overcurrent Relays.

Open-Phase Detectors

The Type SPD Open-Phase Detector, for grounded-system applications, is used in S&C Custom Metal-Enclosed Switchgear, primarily in conjunction with Mini-Rupter Switches driven by the Type MS-10 Switch Operators in load feeder bays. It protects three-phase load circuits from open-phase conditions, including single-phasing.

The SPD detector is a solid-state electronic design and, for switchgear rated 4.16 kV, 13.8 kV, and 25 kV, typically uses S&C Voltage Sensors on the load side of fuses to measure line-to-ground voltages. See S&C Instruction Sheet 542-500.

An S&C Adjustable Burden-Resistor Assembly, which allows precise setting of the voltage sensor's output to the level required by the SPD detector, is mounted adjacent to the detector within the low-voltage compartment. Instructions on operation and adjustment of these detectors and the adjustable burden-resistor assembly are contained in the S&C instruction sheet for Type SPD Open-Phase Detectors.

Voltage Sensors

The S&C Voltage Sensor produces an output voltage directly proportional to line-to-ground voltage. It has relay accuracy over an ambient temperature range of -40° F to +160° F (-40° C to +71° C). See S&C Instruction Sheet 591-500.

In S&C Custom Metal-Enclosed Switchgear, voltage sensors are typically used to replace apparatus insulators at the hinge end of fuses where three-phase sensing for detection of open-phase conditions is required and at the outboard, lower terminal pads of Mini-Rupter Switches (driven by Type MS-2 Switch Operators) to provide voltage sensing for automatic source-transfer schemes.

Alternately, voltage sensors are mounted separately when applied with Alduti-Rupter Switches. The voltage sensor's Cypoxylated™ Assembly construction ensures high cantilever strength and BIL and dielectric characteristics equivalent to those of the apparatus insulator it replaces.

The S&C Voltage Sensor is a constant-current-output device similar to a current transformer, so primary fusing, which is required by a voltage transformer, is eliminated. Secondary conductors of the voltage sensor are shielded from high voltage by switch and fuse frame channels and are connected directly to variable burden resistors. These resistors provide for field adjustment of the voltage sensor output to the level required by automatic control devices. Instructions about adjustment of the voltage sensor's output are included in S&C instruction sheets for the applicable associated devices, i.e., Type SPD Open-Phase Detectors.

Current Sensors

When the optional Overcurrent-Lockout feature (which prevents a transfer operation that would close a source interrupter switch into a fault) is included with the Micro-AT Source-Transfer Control, S&C Current Sensors are provided for attachment to the entrance cables from each source. Current sensors are also furnished with the optional Type ZSD Overcurrent Relay and are typically attached to feeder cables. For instructions on installation of current sensors, see Step 13 on page 25 and S&C Instruction Sheet 514-600.

⚠ WARNING

Check the functional operation and adjustment of mechanical cable interlocks on doors and switch operating mechanisms.

Failure to check and adjust these interlocks may result in personal injury or death.

The switchgear assembly may include interlocks (key or mechanical) on doors, switch operators, etc., of some bays. A few typical interlock schemes, including precautionary measures that must be taken to maintain interlock integrity, are discussed in this section. For the types and locations of interlocks included on the switchgear assembly, and for operating descriptions of special interlocking schemes specified, refer to the “CDA” and “RD” drawings.

Mechanical Cable Interlocks—Operation

Interrupter switches with switch operators may include a mechanical cable interlock that blocks switch operation when the enclosure door is open or unlatched.

Interrupter switches with fuses, whether manually operated or power operated, may include a mechanical cable interlock that prevents opening the enclosure door when the switch is in the **Closed** position (preventing access to fuses) and prevents closing the switch when the door is open or unlatched.

If mechanical cable interlocks are included, do not operate the switch unless the associated enclosure door is closed with the door latches securely engaged. Also, if the bay includes fuses, do not attempt to open the door unless the associated switch is open.

NOTICE

For MS-2 Switch Operators, if an attempt is made to operate the switch when the enclosure door is open, the switch operator will partially discharge and become jammed.

Follow these steps to recover from a jammed condition:

- STEP 1.** Turn the DECOUPLING INDICATOR lever on the switch operator to the right to the **Drawout Stop Release** position and at the same time pull on the hand grip to decouple the switch operator.
- It will take some force to pull the hand grip so the switch operator is decoupled.
 - When decoupled, the switch operator will immediately fully discharge and then will automatically recharge.
- STEP 2.** Release the DECOUPLING INDICATOR lever and make sure it returns to the **Decoupled** position.

Follow these steps to couple the switch operator:

- STEP 1.** Press the OPEN or CLOSE pushbutton (as appropriate).
- The switch operator will trip and automatically recharge. (This procedure returns the switch operator to the same position, i.e. switch operator **Open** or switch operator **Closed**, as the switch).
- STEP 2.** Turn the DECOUPLING INDICATOR lever to the **Drawout Stop Release** position and, at the same time, push on the hand grip to move the operator fully into the enclosure.
- STEP 3.** Release the DECOUPLING INDICATOR lever and make sure it returns to the **Coupled** position.

Mechanical Cable Interlocks— Inspection and Adjustment

Mechanical cable interlocks should be inspected periodically for proper functioning when, for example, the switch is being used. Inspection and adjustment procedures for these interlocks are described below.

WARNING

Inspection and adjustment should only be performed by qualified persons who are experienced in working with energized switchgear. See the “Qualified Persons” section on page 2 for more information. Inspection and adjustment of this type interlock may require access to the interior of the enclosure, resulting in exposure to high voltage. Furthermore, access to the interior may require opening the switch, which will interrupt power to the load.

Follow these steps to inspect the mechanical cable interlocks that prevent opening the door when the switch is closed and closing the switch when the door is open (typically applied on manual and power-operated modules containing fuses):

- STEP 1.** With the switch closed and (if furnished) the snaplock disengaged, attempt to open the high-voltage compartment door. If the door can be opened, the interlock requires adjustment.
- STEP 2.** Open the switch, which will interrupt power to the load. Then, open the high-voltage compartment door.
- STEP 3.** With the door open, attempt to close the switch. If the switch can be closed, the interlock requires adjustment. Make sure prior to closing the switch with an opened door, the upstream device by which this switch is connected should be opened and properly grounded in order to avoid accidents or injury.

Follow these steps to inspect the mechanical cable interlocks that prevent opening or closing the switch when the door is open (typically applied on power-operated modules containing a switch but no fuses):

- STEP 1.** Open the high-voltage compartment door.
- STEP 2.** With the door open, attempt to close the switch. If the switch can be closed, the interlock requires adjustment. Make sure prior to closing the switch with an opened door, the upstream device by which this switch is connected should be opened and properly grounded in order to avoid accidents or injury.

Follow these steps to adjust the mechanical cable interlocks:

- STEP 1.** To adjust the interlock, bring the door nearly closed to a point where both the locking lever pin (which is part of the locking-lever assembly on the enclosure stile) and the drive-plate tip (which is part of the interlock mechanism on the enclosure door) are visible and in close proximity. See Figure 17 on page 39.
- STEP 2.** Verify the distance from the surface of the locking lever pin to the tip of the drive plate is $\frac{5}{16}$ -inch (8 mm) \pm $\frac{1}{16}$ -inch (1.6 mm).
- STEP 3.** If adjustment is necessary to gain the correct dimension:
 - (a) Loosen the two nuts securing the locking lever assembly to the enclosure tile.
 - (b) Position the cable housing bracket relative to the locking lever plate so there is $\frac{15}{32}$ -inch (8 mm) \pm $\frac{1}{16}$ -inch (1.6 mm) between the tip of the locking lever and the surface of the locking lever plate.
 - (c) While maintaining the dimensional relationship established in (b) above, simultaneously slide both the cable housing bracket and the locking lever plate vertically to achieve the $\frac{15}{32}$ -inch (8 mm) dimension.
 - (d) Tighten the bolts.

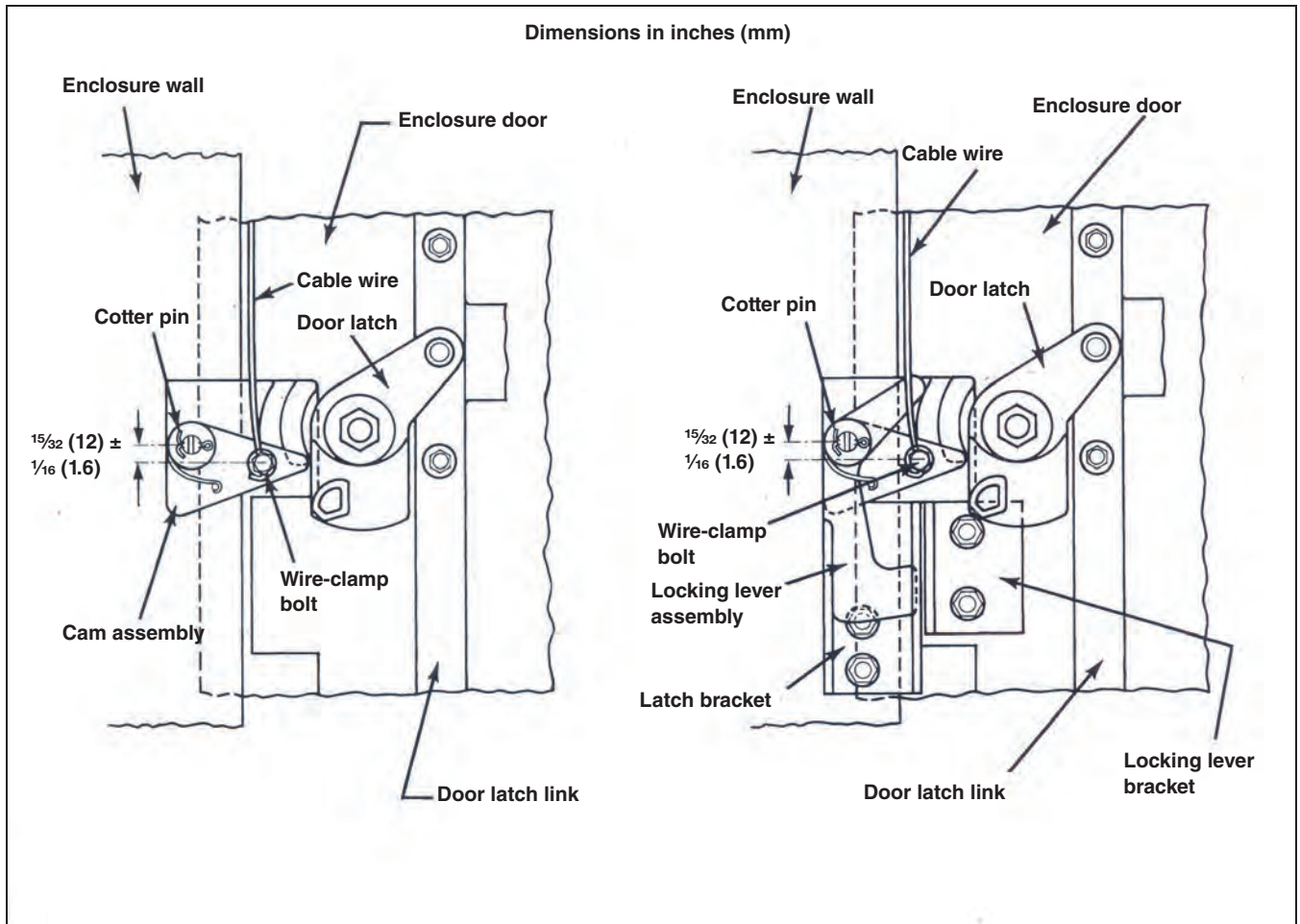


Figure 17. Dimensions to achieve proper alignment of mechanical cable interlocks which (a) prevent switch operation when the enclosure door is open or unlatched or (b) prevent opening the enclosure door when the switch is closed and closing the switch when the door is open.

Key Interlocks

WARNING

When optional key interlock schemes have been furnished, duplicate keys are provided for use during installation. If duplicated keys are made available after installation, it can increase the chances of using the key interlocks when they are not supposed to be used. **This can result in unwanted operation, which could result in serious injury or death.** To maintain the integrity of the key interlock scheme, the duplicate keys must be destroyed or made accessible only to authorized persons.

Note: Key interlocks are not security locks and are not a substitute for padlocks.

Entrance interrupter switches with fuses, whether manually operated or power operated by Type MS-2 or Type AS-30 Switch Operators may include key interlocks that guard against opening the enclosure door unless all associated entrance switches are open. If such key interlocks are included, do not attempt to open the enclosure door unless the associated switches are open. See (a) in Figure 18 on page 41.

Entrance bays may include key interlocks that guard against opening the enclosure door unless an associated upstream or downstream device is open. If such key interlocks are included, do not attempt to open the enclosure door unless the associated device is open. See (b) in Figure 18 on page 41.

Entrance interrupter switches, with or without fuses, whether manually operated or power operated by Type MS-2 or Type AS-30 Switch Operators may include key interlocks that guard against paralleling the power sources. If such key interlocks are included, do not attempt to close a source-interrupter switch unless the other source-interrupter switch, or bus-tie switch in split-bus configurations, is open. See (b) and (c) in Figure 18 on page 41.

Feeder interrupter switches with fuses and manually operated may include key interlocks that guard against opening the enclosure door unless the associated switches are open. If such key interlocks are included, do not attempt to open the enclosure door unless the associated switches are open.

Feeder interrupter switches, with or without fuses, whether manually operated or power operated by Type MS-10 Switch Operators may include key interlocks that guard against opening the enclosure door unless an associated upstream or downstream device is open. If such key interlocks are included, do not attempt to open the enclosure door unless the associated device is open. See (d) in Figure 18 on page 41.

NOTICE

Use of undue force in an attempt to operate switches contrary to the correct sequence dictated by the key interlock scheme may damage handles or latching mechanisms.

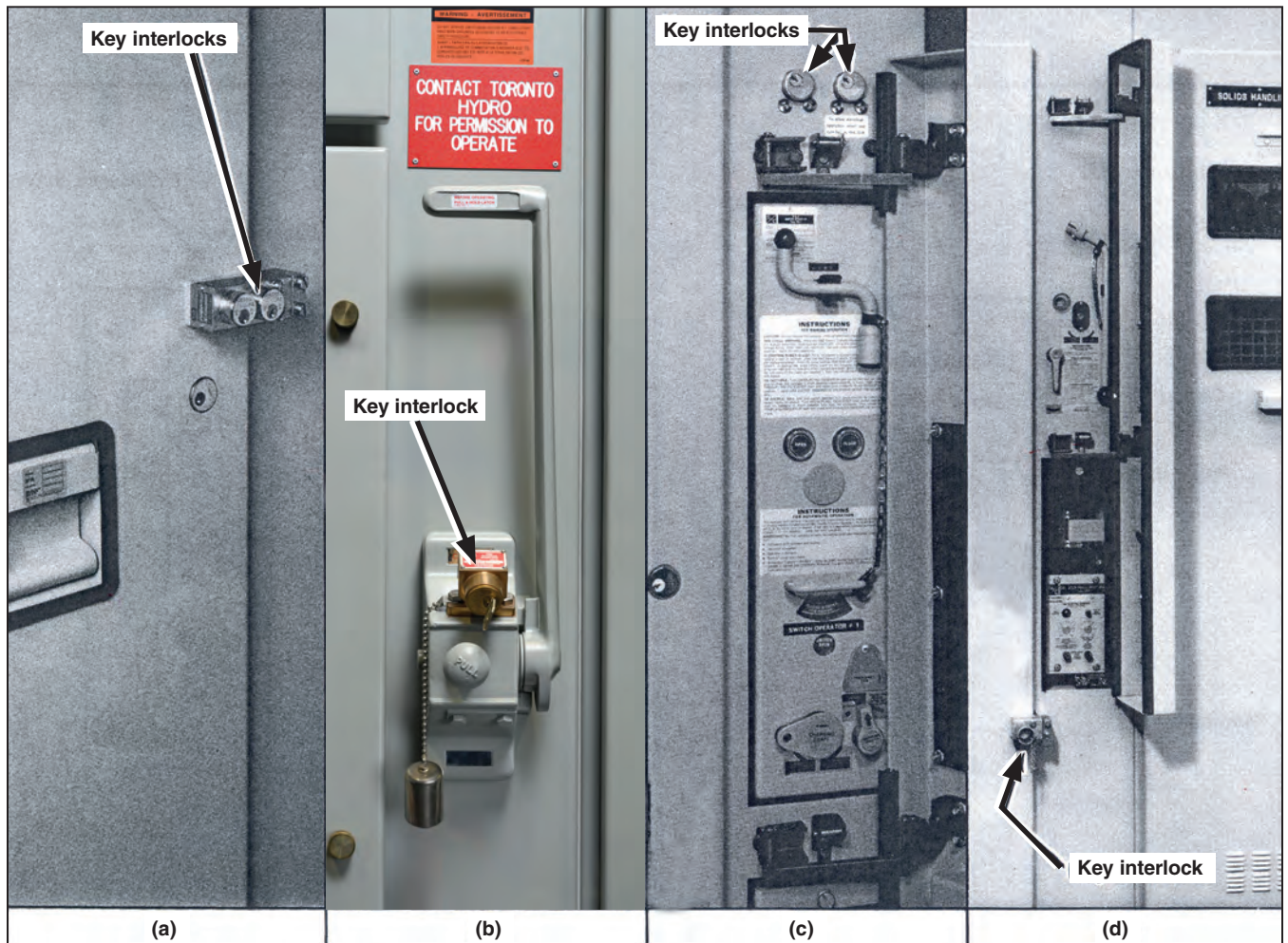


Figure 18. Key interlocks (a) on compartment door to guard against opening the compartment door unless the associated switch is open, (b) on manual switch-operating handle to guard against paralleling of the power sources and to guard against opening the door unless upstream and downstream devices are open, (c) on Type MS-2 Switch Operator to guard against paralleling of the power source, and (d) on compartment door (Type MS-10 Switch Operator shown) to guard against opening compartment door unless the associated upstream or downstream device is open.

Maintenance

Maintenance recommended● consists of periodic cleaning and inspection of the interrupter-switch, fuse, and bus-support insulators; barriers; cable-terminating devices; and louver filters (if furnished), which should be performed at intervals based on environmental conditions.

The integrity of the enclosure finish should be checked, and any scratches or chips should be touched up with the appropriate touch-up finish.

Occasional exercising of interrupter switches, switch operators, and all automatic control equipment, as well as inspection of interlocks for correct functioning, is recommended. Specific recommendations on exercising are included in the S&C instruction sheet applicable to each component as well as in S&C inspection recommendations provided in the instruction manual furnished with the switchgear. To verify the correct functioning of interlock schemes; refer to the “Interlocks” section starting on page 37.

The frequency of inspection and maintenance necessary will vary and largely depend on the environmental conditions and location of the metal-enclosed switchgear. S&C recommends utilities perform all routine inspection by checking, cleaning, and maintaining the equipment in accordance with established utility standards and industry best practices. In the event the recommendations contained in this instruction sheet differ in any way from the user’s operating and safety procedures, follow the user’s operating and safety procedures.

Fuse replacement is infrequent because for cable systems there is no exposure to transient faults, only to rare permanent faults.

The inspection and maintenance recommendations and obligations stated above shall be the sole responsibility of the user. The warranty and/or obligations of S&C described in S&C Price Sheet 150, “Standard Conditions of Sale – Immediate Purchasers in the United States” (or Price Sheet 153, “Standard Conditions of Sale – Immediate Purchasers Outside the United States”), S&C Price Sheet 192T for Canada, or any special warranty provisions set forth in the applicable product line specification bulletin, shall only be applicable upon confirmation the product at issue has been stored, installed, operated, and maintained in accordance with these recommendations and standard industry practice. S&C shall not be liable for any damage or loss whatsoever arising out of or resulting from the user’s failure to perform the necessary inspections and maintenance of the products covered in this publication.

● These recommendations may differ from the user’s operating and safety procedures. Where a discrepancy exists, follow the utility operating and safety procedures.

Performing Maintenance in High-Voltage Bays

WARNING

When access to high-voltage bays is required, it must be restricted to qualified persons. See the “Qualified Persons” section on page 2 for more information. Follow prescribed safety rules at all times. **Failure to do so can result in personal injury or death.**

Follow these steps for specific maintenance requirements:

- STEP 1.** Disconnect the fuses, interrupter switches, power switching equipment and their mechanisms, and any other devices from all power sources and all control sources before that device is inspected, serviced, or repaired.
- STEP 2.** Always assume both sets of power terminals on any interrupter switch, fuse, or terminal to be energized unless proved otherwise by test or by visual evidence of open-circuit conditions on both terminal ends.
- STEP 3.** Test for voltage. Know how to operate the correct test equipment for determining the voltage on both sets of power terminals for any fuse or interrupter-switch equipment.
- STEP 4.** After the switchgear has been completely disconnected from all sources of power, properly connect grounding leads to both sides of the equipment (to the incoming and the outgoing phases of the equipment to be maintained).

STEP 5. Make certain the switch-operating handles, operator housings, and metal enclosures are properly grounded.

STEP 6. Inspect and adjust all interlocks.

NOTICE

When control-source fuse replacement is required in Type MS Switch Operators or S&C Source-Transfer Controls, use only fuses as designated in the applicable switch operator instruction sheets. When bulb replacement is performed in source-transfer controls, use only designated S&C replacement bulbs. Costly damage to the switch operator or controls could result when the wrong fuse or bulb is used.

Maintaining Low-Voltage Components

Occasionally low-voltage components may require maintenance. When servicing or repairing space heaters, voltage-transformer secondary wiring, and any other components located in the high-voltage compartment, all of the preceding safety procedures apply.

Follow these steps when external voltage is used to test any secondary side wiring or devices:

WARNING

When access to high-voltage bays is required, it must be restricted to qualified persons. See the “Qualified Persons” section on page 2 for more information. Follow prescribed safety rules at all times. **Failure to do so can result in personal injury or death.**

- STEP 1.** Disconnect all voltage transformers and voltage sensors when external voltage is used to test any secondary side wiring or devices. This prevents energizing the high voltage conductors through voltage transformers or sensors.
- STEP 2.** Draw out the voltage transformers completely and disconnect the secondary connections if drawout-type transformers are provided.
- STEP 3.** Remove the primary fuses of the voltage transformers and disconnect the secondaries by removing the secondary fuses or by disconnecting the secondary leads.
- STEP 4.** Do not disconnect the burden or the voltage limiter from the voltage sensor until the switchgear is de-energized; otherwise the voltage sensor will be damaged.
- STEP 5.** For voltage sensors, the secondary leads must be shorted either by removing the plug from the input receptacle and transferring it to the shorting receptacle for applications involving the Micro-AT Source Transfer Control, Type SPD Open Phase Detector or by inserting screws into shorting-type terminal blocks. See Figure 13 on page 25.

Maintaining Other Low-Voltage Components (600 volts or less)

The maintenance of other low-voltage components (such as voltmeters, ammeters, relays, etc.), isolated from high-voltage bays, may be performed under the safety rules for equipment rated 600 Volts or less.

If maintenance is to be performed on ammeters, short-circuit the secondary connections of the associated current transformer at the shorting-type terminal block prior to removal of the ammeter. This may require access to the high-voltage compartment, in which case the foregoing procedures apply.

Follow these steps to return the equipment to service:

- STEP 1.** Reconnect any low-voltage terminals disconnected when servicing the gear. Re-install any primary or secondary fuses previously removed.
- STEP 2.** Close and securely latch each switchgear-bay door before energizing the circuit or operating any switching device.
- STEP 3.** Open any grounding switch, or remove other grounding means, before closing the associated interrupter switch(es).
- STEP 4.** Lock interrupter switches in the **Open** or **Closed** position, as dictated by the electric power system design.
- STEP 5.** Padlock all doors, switch-operating handles, and covers before leaving the installation site, even momentarily. Observe this procedure even when the gear is accessible only to qualified persons.