INSTRUCTIONS

For Installation and Operation

TYPE PVE
DEADFRONT PAD-MOUNTED SWITCHGEAR
15kV • 25kV

Qualified Persons

⚠ WARNING

The equipment covered by this publication must be selected for a specific application and it must be operated and maintained by **Qualified Persons** who are thoroughly trained and knowledgeable in the installation, operation, and maintenance of underground power distribution equipment along with the associated hazards that may be involved. This publication is written only for such qualified persons and is not intended to be a substitute for adequate training and experience in safety procedures for this type of equipment. Proper installation is the responsibility of the operating and construction personnel and the utility performing and authorizing the work. Completion of these instructions implies no further warranty by the manufacturer.

A **Qualified Person** is defined in the National Electrical Code (NEC/NFPA-70) as:

One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.

The specific electrical safety training requirements to be considered a qualified person are detailed in **NFPA-70E, Article 110.1(D), Employee Training**. Some of the requirements from the 2012 edition are shown below. For the specific detailed training requirements for a Qualified Person make certain to refer to the most recent applicable edition.

These training requirements would include, but are not limited, to the following key points:

• The skills and techniques necessary to distinguish exposed energized parts from other 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 the special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools for working on or near exposed energized parts of electrical equipment.

• Tasks performed less often than once per year have additional training requirements.

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. Additionally, the recommendations in this instruction bulletin are not intended to supersede or to take the place of established utility safety guidelines and established practices. If there is any question, consult with your foreman or supervisor, as appropriate.

Please refer to OSHA 29 CFR 1910.399 and NFPA 70E Articles 100 and 110.

SAFETY INFORMATION

Understanding Safety-Alert Messages

There are several types of safety-alert messages which may appear throughout this instruction bulletin as well as on labels attached to the padmounted switchgear. Familiarize yourself with these types of messages and the importance of the various signal words, as explained below.

⚠ DANGER

"**DANGER**" identifies the most serious and immediate hazards which will likely result in serious personal injury or death if instructions, including recommended precautions, are not followed.

⚠ WARNING

"**WARNING**" identifies hazards or unsafe practices which can result in serious personal injury or death if instructions, including recommended precautions, are not followed.

⚠ CAUTION

"**CAUTION**" identifies hazards or unsafe practices which can result in minor personal injury or product or property damage if instructions, including recommended precautions, are not followed.

⚠ NOTICE

"**NOTICE**" identifies important procedures or requirements that, if not followed, can result in product or property damage if instructions are not followed.

SAFETY PRECAUTION

⚠ DANGER

Federal Pacific Fuse Mountings in conjunction with appropriate fuses are designed to protect equipment and to disconnect faulted equipment from the system. The fuses cannot protect personnel from injury or electrocution if contact is made with energized circuits or hardware.

FOLLOWING SAFETY INSTRUCTIONS

⚠ NOTICE

Thoroughly and carefully read this instruction bulletin before installation of the pad-mounted switchgear, before switching or operating the switches or fuse mountings in this equipment, and before performing any maintenance on the equipment.

If you do not understand any portion of this instruction bulletin and need assistance, contact Federal Pacific at 276-466-8200.

Replacement Instructions & Labels

If you need additional copies of this instruction bulletin, contact Federal Pacific at 276-466-8200.

It is important that any missing, damaged, or faded labels on the equipment be replaced immediately. Replacement labels are available by contacting Federal Pacific.

INTRODUCTION

Type PVE Pad-Mounted Switchgear is designed to provide dependable on-the-line service and to make installation, operation and maintenance as simple as possible.

High quality materials and careful workmanship have been combined to provide the best switchgear available. The switchgear has been thoroughly inspected and adjusted at the factory. However, successful operation depends on proper installation and care.

This manual has been written to assist you in obtaining long and economical service from your switchgear.

Read this manual before installing and operating your switchgear.

Receiving

Upon receipt of the switchgear, check each item received for shipping damage. Each item should be checked against the shipping manifest to assure that the proper number of items were received. Should any shortage or damage exist, note it on the shipping papers. A claim should be filed at once with the carrier and the Federal Pacific agent or sales office should be notified.

Handling

Removable lifting plates are provided to allow the use of hooks to lift the complete enclosure. The lifting device should be arranged to evenly distribute the lifting force between the lifting plates that will vary between two and four depending on the size of the unit.

⚠ CAUTION

Do not lift at an angle less than 60° from the horizontal. See Figure 1. Failure to comply with this requirement may result in damage to the equipment.

The switchgear is securely mounted to a sturdy shipping pallet with provisions for forklift use. The use of a forklift truck is not recommended, but if this method is used the forks must extend completely through the skid to avoid damaging the equipment.

Storage

The switchgear as received may be wrapped in a protective plastic film.

⚠ NOTICE

To avoid damage to the enclosure finish, the protective film must be removed for outdoor storage of unit.

For extended storage beyond 30 days, precautions must be taken to maintain adequate charge on batteries and to energize heaters in a manner that does **NOT** energize bus through any voltage transformers.

Export or special packing is available as an option based on customer's requirements and special conditions. Separate instructions are available for these situations.

GENERAL DESCRIPTION

Type PVE deadfront pad-mounted switchgear consists of one or more three-pole, gang-operated, quick-make, quick-break, vacuum interrupters or Auto-jet II® load interrupter switches that may be used in combination with one or more three-phase relayed vacuum fault interrupters. Switches are typically equipped with 600 ampere bushings to accommodate 600 ampere elbow connectors.

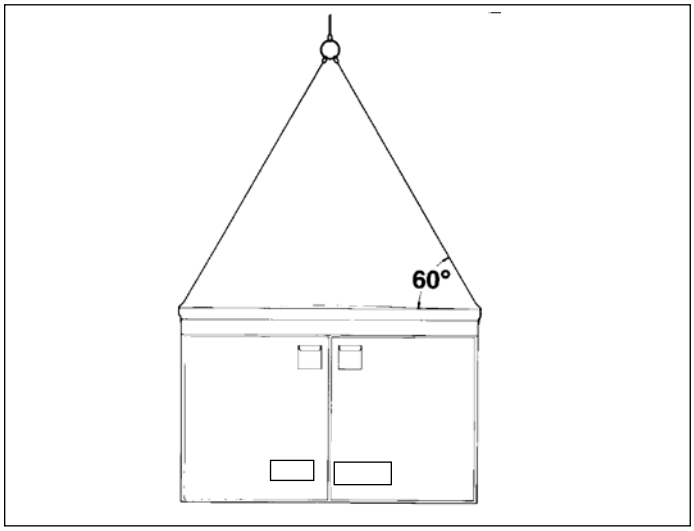


Figure 1. Lifting Method

Relayed vacuum fault interrupters are typically equipped with 200 ampere bushing wells to accommodate 200 ampere loadbreak (or non-loadbreak) inserts and elbows. Alternately, switches can be equipped with 200-ampere bushing wells and vacuum fault interrupters can be equipped with 600-ampere bushings. Vacuum Interrupters and Auto-jet®II Load-Interrupter Switches are furnished for load switching with manual operation but can also be supplied (as described later) with a choice of optional relays or optional motor operators and relays to achieve various levels of automation and (in some applications) over-current protection (fault interruption) on the associated main-primary feeder circuit. Similarly, relayed vacuum fault interrupters are furnished with a self-powered relay and a magnetic latch for automatic tripping and with manual reset, but can also be supplied (as described later) with optional motor operators and a choice of optional relay packages to achieve various levels of automation and protection on the associated load-feeder circuit. The PVE switchgear provides a secure and efficient means of 3-pole switching on main feeders and three-phase circuit protection with relayed vacuum fault interrupters on load feeders.

SECURITY FEATURES

Type PVE pad-mounted switchgear incorporates a number of security features to minimize hazards to operating personnel.

1. Rugged 11-gauge steel, braced by all welded construction of the enclosure, roof, and doors assures a tamper-resistant design.
2. Padlockable switch operating pocket handles and doors with security bolts provide customer-controlled access.
3. Switch position indicators verify positive switch position.
4. Provisions to padlock switch in open or closed position provide user controlled switch operation (optional).
5. Key interlocks to ensure a pre-determined sequence of mechanical operations (optional). The existence of key interlocks and the sequencing will be noted on the drawings.
6. Hazard-alert signs and labels, both external and internal, which indicate potential hazards to personnel.

INSTALLATION

Each unit is shipped with this instruction bulletin which is located inside the switch compartment door. These instructions should be reviewed prior to placing unit on pad.

Placement of Unit

Remove unit from shipping pallet — one located at each corner of the unit in the interior at the bottom flange and — retain the four (4) tie-down plates to later secure the enclosure to the pad) per handling procedures on Page 3 (see Figure 1). When unit has been correctly oriented and placed on pad (see Figure 2), verify that unit is level and shim if necessary between unit base and pad. Secure unit to pad using four (4) tie-down plates as furnished (see Figures 3 and 4). Check compartment door operation for any binding due to enclosure distortion and re-shim if necessary. A recessed grouting should then be applied between unit base and pad to prevent entry of foreign objects and moisture.

Current Sensing Devices

Inspect the current sensing devices provided with the equipment and verify type, method of installation on cables, orientation, polarity and that all connections are secure. Make certain to install the current-sensing device appropriately with respect to the cable concentric neutral as described on page 11.

Customer Cable Connections

1. Properly install current sensing devices with cables passing through the window opening and keeping the cable centered in the opening. Verify correct polarity orientation for current sensing devices before installing terminators.

2. Make up the primary cable connections per user's standard URD operating procedures, cable manufacturer instructions, and elbow terminator manufacturer instructions. The concentric neutral wires must pass back through the current-sensing device before being taken to ground as described on page 11.

3. Connect the concentric neutral wires to the enclosure ground pads inside enclosure to facilitate ground system conforming to user's grounding procedures.

⚠ WARNING

The maximum momentary rating of the switchgear must be considered when selecting cable size for connecting switchgear to system ground. Refer to unit rating plate.

4. Install fault indicators, if applicable.

5. Verify that all connections to CTs remain secure.

AUTO-JET® II SWITCH OPERATION

The Auto-jet® II switch provides a unique method of load interruption, producing a laminated jet of air which extinguishes the arc.

Auto-jet® II switches have a heavy gauge steel, all welded base frame that assures proper alignment and eliminates any problem with switch-to-enclosure alignment. A quick-make, quick-break stored energy mechanism with heavy-duty, long-life die springs (or stainless-steel springs where all stainless-steel switches are specified) provides high speed opening and closing independent of the operating handle speed.

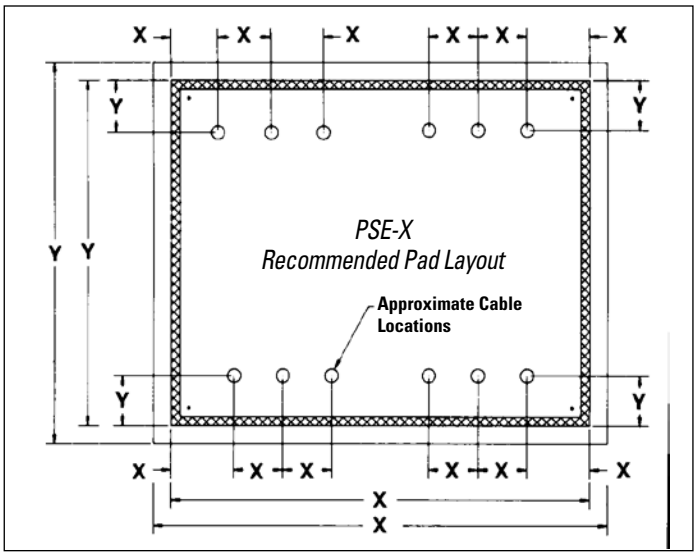


Figure 2. Typical Pad Layout

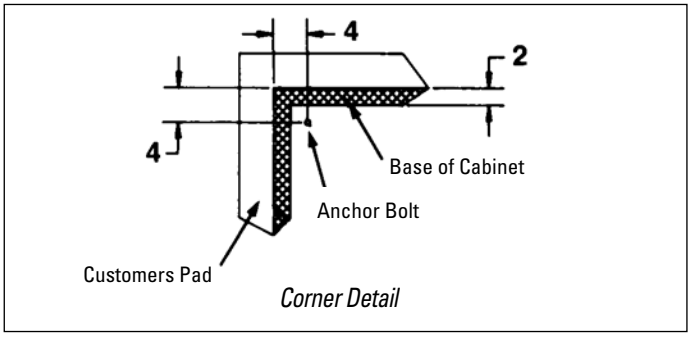


Figure 3. Typical Anchor Bolt Location

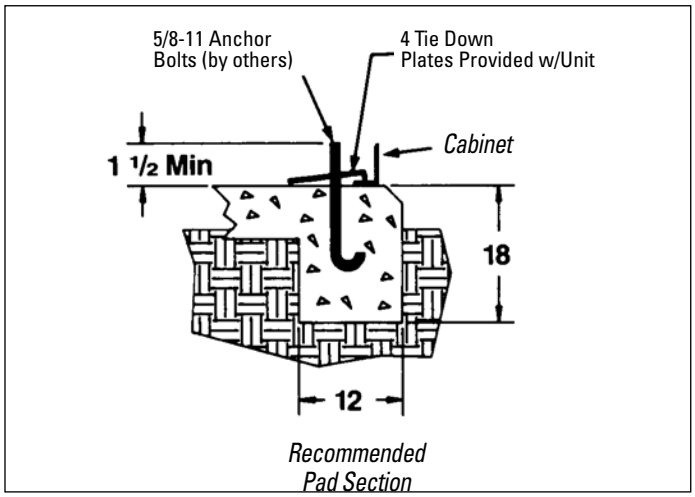


Figure 4. Bolting Units to Pad

Auto-jet® II Switch Operating Sequence

The operating sequence of the Auto-jet® interrupter is pictured in the left-hand column in Figures 5(a) through 5(d) and the corresponding positions of the switch and its mechanism are pictured in the right-hand column. The Auto-jet® interrupter consists of a piston (A) mounted in the cavity of the upper insulator. The movable arcing probe (B) engages a tulip contact (C) inside the piston. As the switch blade (D) is pulled open by the stored-energy mechanism, the blade separates from the main-contact stab (E). The piston is pulled forward by means of the movable arcing probe, which compresses a heavy gauge spring encircling the piston and a spring encircling the arcing probe. At the end of its travel, the piston is released from the arcing probe and, under the action of the heavy spring, is rapidly pushed backward into the cavity. This travel produces a jet of laminated compressed air up through the center of the piston, which extinguishes the arc. The spring encircling the movable arcing probe rapidly retracts the probe and increases the speed of separation, which prevents restrike. All of this action is in addition to the spring energy transmitted to the switch blades by the quick-make quick-break mechanism of the switch.

Cutaway Views of Interrupter

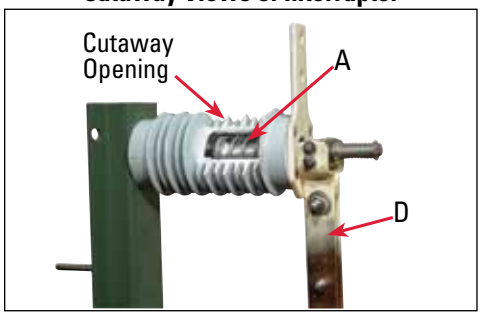
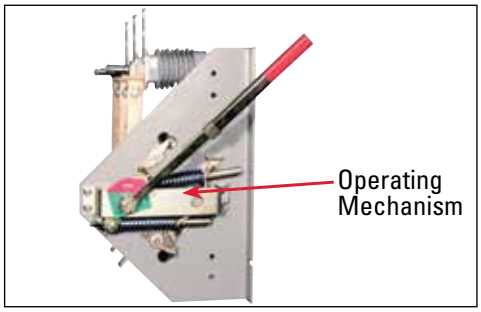


Figure 5(a)
Switch closed with opening spring relaxed.

Views of Switch



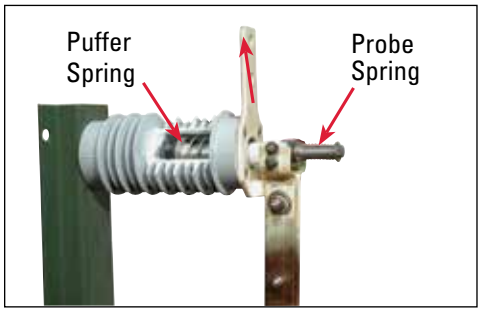
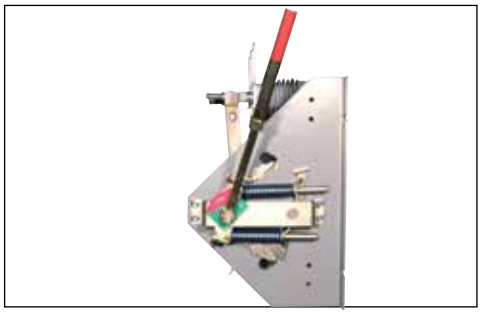


Figure 5(b)
Switch closed with opening spring charged by manual operating handle.



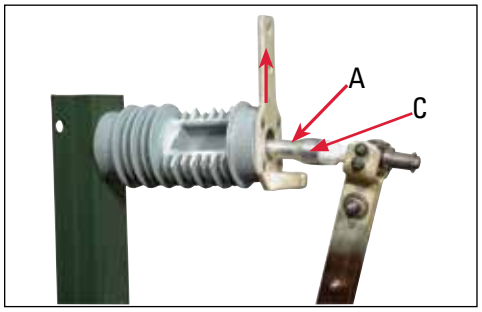
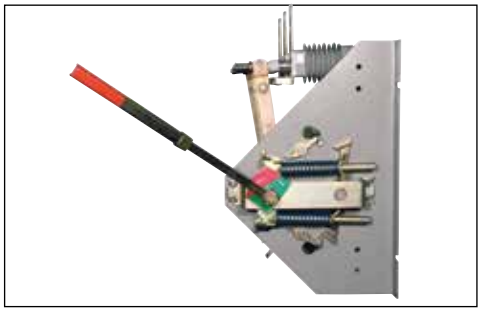


Figure 5(c)
Main contacts parted, puffer and arcing springs charged. (Simulated condition for illustrative purposes, actual duration of event is approx. 1/2 cycle.)



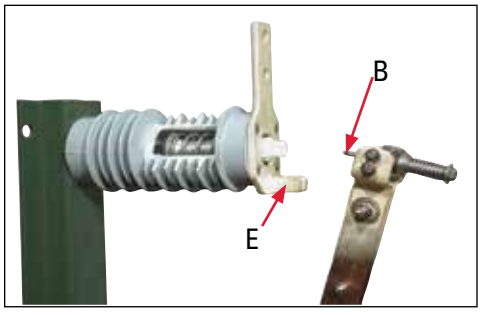


Figure 5(d)
Switch open with latch engaged to hold switch in position.

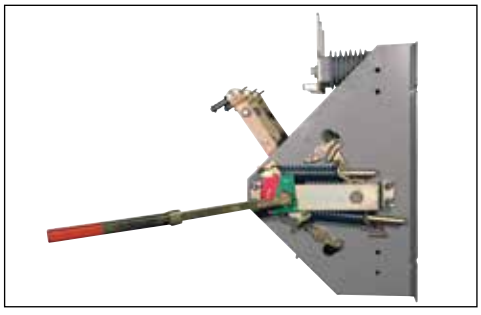


Figure 5. Sequence of operation for Auto-jet® II switches.

Operating the Auto-Jet® II Switch

The operating handle for the Auto-jet® II switch is located behind a padlockable cover on the side of the pad-mounted switchgear. The handle is secured to the enclosure by a stainless steel cable. In typical installations, the Auto-jet® II switch is a two-position (open or closed) switch. In very particular circumstances, the switch may be integrated with a ground position but still remains applied as a two-position (open or grounded) switch. These two cases (switch without ground position and switch with ground position) are discussed below.

a. Accessing the Switch-Operating Handle

   i. Remove padlock and open the switch lockbox access cover. (See Figures 7 and 8.)

   ii. Remove switch operating handle from storage clips. Unfold the handle and secure in the extended position by sliding the clamp over the hinged section (see Figure 9). Place the handle on the hex switch-operating shaft (see Figure 10). If provision to padlock switch in open or closed position is provided (K2 option), the additional padlock (if installed) must be removed before access to hex switch-operating shaft can be accomplished.

   If key interlock(s) are provided (K1, K3 or K4 options), switch may be locked in the open position or the closed position, depending on the specific requirements. Refer to the drawings and labels on the switchgear for information on the key interlock scheme, if specified.

b. Operating the Switch Open/Closed (i.e. no ground position).

   Grasp the handle firmly and rotate handle in the direction as indicated on the label to open or close switch. Verify switch position by observing the switch position indicator in the handle pocket and by inspecting the switch through the viewing window provided either in each switch termination compartment or adjacent to the switch-operating handle lockbox. (See Figures 11 to 14.)

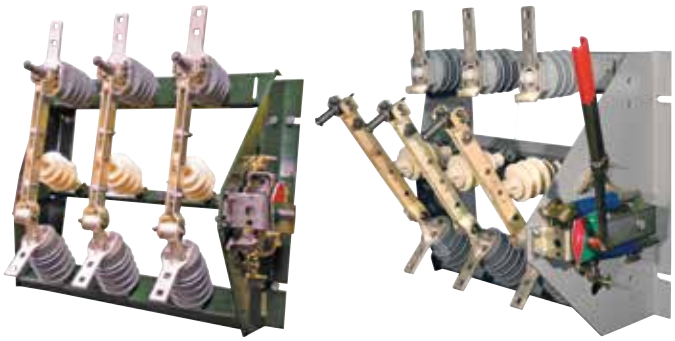


Figure 6. Views Show Auto-jet® II Switch (No Ground Position). 15-kV Auto-jet® II Switch Shown in Closed Position at Left and in Open Position at Right.

Figure 7. Remove padlock.

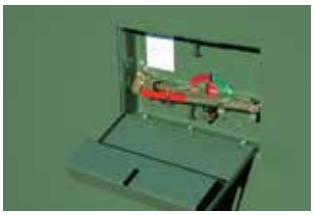


Figure 8. Open switch lockbox access cover. Handle is connected to enclosure by a cable.

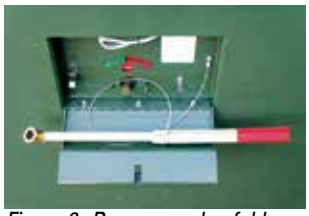


Figure 9. Remove and unfold handle. Secure handle in the extended position by sliding clip over joint of handle sections.

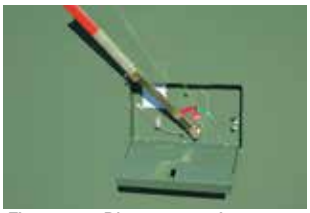


Figure 10. Place operating handle on hex shaft of switch. Rotate handle in desired direction as shown by switch position indicator.

Figure 11. Hinged padlockable cover over switch-viewing port (an alternate arrangement).

Figure 12. Alternate switch-viewing port.

Figure 13. Alternate switch-viewing port and operating handle extended.

c. Operating the Switch Closed/Grounded (i.e. ground position is the open position)

⚠ WARNING

When operating this switch from the closed position, be aware that it moves directly to a ground position. There is no open position that is not grounded. Therefore, extreme caution must be exercised before rotating the handle from the closed position to the ground position to insure that the circuit on the ground side is de-energized and not energized. Failure to insure that the circuit is de-energized may result in a violent arc-hazard event that can result in equipment damage, personal injury or death.

⚠ CAUTION

Access cover should be padlocked whenever switchgear is left unattended.

(i) In many instances, the switches with a ground position also include a key-interlock scheme that provides for a specific switching sequence to be performed to make certain the circuit is de-energized before the switch can be operated to the GROUNDED position. Make certain to follow the applicable switching sequence, which may be published in a separate document or drawing, before operating the switch to the GROUNDED position.

(ii) Grasp the switch-operating handle and rotate the handle in the direction as indicated on the label to trip the switch to the GROUND position. Verify switch position by observing the switch-position indicator in the handle pocket and by inspecting the switch through the viewing window provided either in each switch termination compartment or adjacent to the switch-operating handle lockbox.

d. Securing the Switch-Operating Handle

i. Remove handle from hex shaft, fold it for storage and place in the correct orientation on the clips for storage. Make certain to place the handle in the clips so it will not be exposed to standing moisture that may collect in the handle pocket, which is stainless steel.

ii. Close switch lockbox access cover and padlock.

iii. Switch position should be visually verified by opening access door of switch termination compartment (or the cover over the viewing port), and checking actual switch position through viewing window. See Figures 13 and 14.

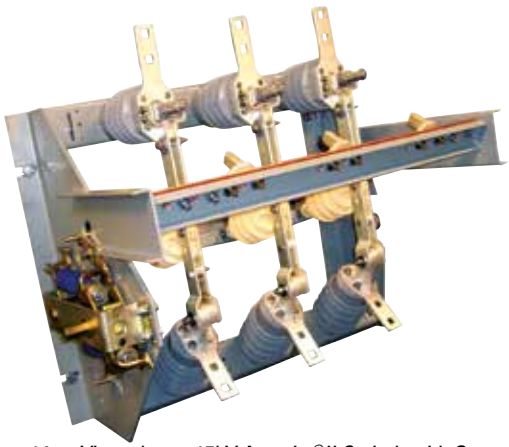


Figure 14.a. View shows 15kV Auto-jet® II Switch with Ground Position. Switch is in CLOSED position.

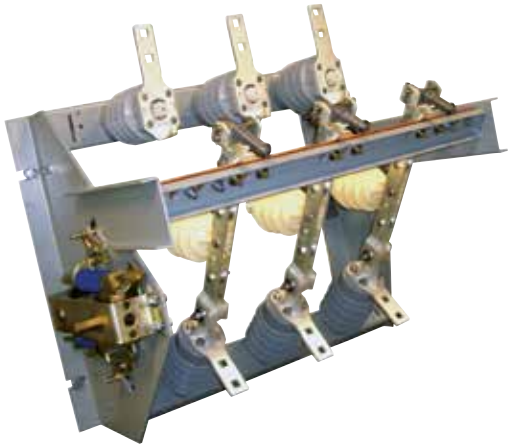
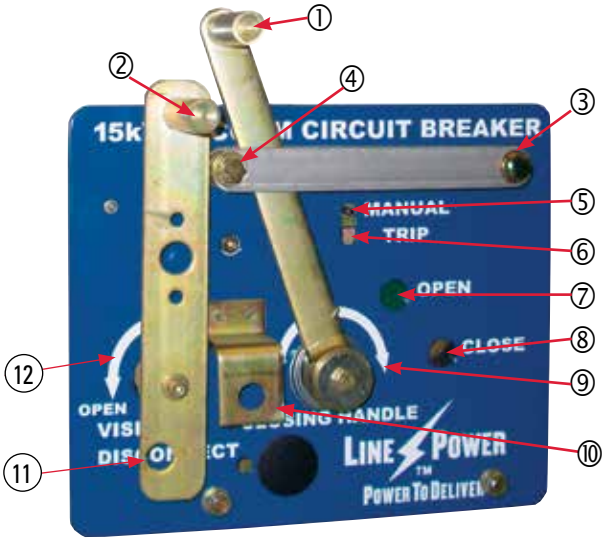


Figure 14.b. View shows 15kV Auto-jet® II Switch with Ground Position and switch is in the GROUNDED position.

Figure 15. Visually verify switch position through switch viewing window. Viewing window orientation and position will vary depending on the specific unit design. Viewing window in termination compartment above is typical.

VACUUM INTERRUPTER OPERATION



1. Manual-Crank Handle for Vacuum Interrupter
2. Visible-Disconnect Operating Handle
3. Right Crank Stop
4. Left Crank Stop
5. Manual TRIP Pin (when in UP position) to Trip Open Vacuum Interrupter
6. Manual RESET Pin (when in Down position) to Reset Self-Powered Relay Actuator
7. OPEN Target (Green when open; Grey when not open) for Vacuum Interrupter
8. CLOSE Target (Red when closed; Grey when not closed) for Vacuum Interrupter
9. Arrow Shows Cranking Direction for Closing Vacuum Interrupter
10. Padlock Tab - Allows Visible Disconnect to be Padlocked Open
11. Hole in Visible-Disconnect Handle for Padlocking Visible Disconnect Open
12. Arrow Shows Cranking Direction for Visisble Disconnect

Figure 15. Faceplate of left-hand vacuum interrupter used to define manual operation of the vacuum interrupter, the operating handles and manual reset. Opposite hand rotation applies to right-hand vacuum interrupters.

Manual Operations

a. Manual Crank-Close Operation

The Manual-Crank Handle can only be used to close the vacuum interrupters. To manually close an open vacuum interrupter, first make certain the visible disconnect is closed. NOTE: The vacuum-interrupter contacts cannot be closed if the visible disconnect is open. With the visible disconnect closed, grasp the manual-crank handle (see Figure 15) and with a firm steady pumping motion first move the handle clockwise to the right stop and back to the left stop; second, repeat the motion — move the handle clockwise again to the right stop and back to the left stop; and third, repeat the motion — move the manual-crank handle clockwise to the right stop. During this third move, the close spring will discharge and the vacuum-interrupter contacts will close, which will be signified by the appearance of the "red" target in the "CLOSE" target port and the disappearance of the "green" target in the "OPEN" target port.

NOTICE

NOTE: There are left-hand (which is illustrated and described) and right-hand vacuum interrupters so that the opposite direction of rotation will apply when right-hand vacuum interrupters are being operated.

When in the close condition, any move to open the visible disconnect will trip the vacuum-interrupter contacts open.

b. Manual Trip-Open Operation

To manually trip-open a closed vacuum interrupter, press down on the manual-trip pin (see Figure 15); the mechanism will immediately discharge opening the vacuum-interrupter contacts. When tripped open, the green target appears in the OPEN target port; and the red target disappears from the CLOSE target port. The Manual-Crank Handle cannot be used to open the vacuum interrupters. When the vacuum interrupter has been tripped open, the visible disconnect can be operated, refer to "Visible Disconnect Operation" on page 10.

Electrical Operations

a. Trip-Open Operations Initiated by On Board Relays

- In Response to Self-Powered Relay
  When the vacuum fault interrupter is tripped open in response to a pulse from a Self-Powered Relay (see Figure 17), the Trip Pin will remain in the down position and MUST be reset in the UP position before the vacuum interrupter can be cranked closed and set for a subsequent trip-open operation (i.e. the vacuum interrupter will be non-functional after responding to a trip signal from the Self-Powered Relay until the Trip Pin is reset in the UP position). When tripped open, the green target appears in the OPEN target port; and the red target disappears from the CLOSE target port. When the vacuum interrupter has been tripped open, the visible disconnect can be operated, refer to "Visible Disconnect Operation" on page 10.

NOTICE

NOTE: When installing cables, make certain the CTs are positioned on the correct phase and with the proper polarity orientation. For setup and operation of the Self-Powered Relay, refer to Federal Pacific Instruction Bulletin IB-11A-210 furnished with the equipment.

- In Response to All Other Relay Types
  The vacuum fault interrupters may be operated using input signal from a variety of different relay types such as the SEL-501 (see Figure 18). For all other relay types except the Self-Powered Relay, when the vacuum fault interrupter is tripped open in response to a pulse, the Trip Pin will return to the UP position. The vacuum fault interrupter can be cranked closed, if the visible disconnect is closed, without any reset required. When tripped open, the green target appears in the OPEN target port; and the red target disappears from the CLOSE target port. When the vacuum interrupter has been tripped open, the visible disconnect can be operated, refer to "Visible Disconnect Operation" on page 10.

Figure 16. Right-hand operating vacuum fault interrupter is shown in the above views. Press manual trip pin (view at top left) to open vacuum interrupters. Open visible disconnect (view at top right) using visible-disconnect operating handle. View at bottom left shows manual trip pin reset and visible disconnect closed. For vacuum fault interrupters controlled by a self-powered relay, the manual trip pin must be manually reset in the open position before a closing operation can be initiated.

⚠ NOTICE

NOTE: When installing cables, make certain the CTs are positioned on the correct phase and with the proper polarity orientation.

For setup and operation of all other relay types, refer to the instruction manual from the manufacturer of the particular relay being supplied and that is provided with the pad-mounted switchgear.

b. Trip-Open Operations Using Local-Trip Capabilities

- On Self-Powered Relay
  The Self-Powered Relay includes a Manual-Trip Switch (see Figure 17a) that allows a local-trip capability to be initiated from the faceplate of the relay. Pressing the Manual-Trip Switch will initiate a trip-open operation of the vacuum fault interrupter. After initiating a trip-open operation, the Manual-Trip Pin on the faceplate of the Vacuum Fault Interrupter **MUST** be reset to the up position to allow a subsequent closing operation using the Manual-Crank Handle. When the vacuum interrupter has been tripped open, the visible disconnect can be operated, refer to "Visible Disconnect Operation" on page 10.

- On Low-Voltage Control Panel
  When other relays are used, such as the SEL-501, a Manual-Trip Switch may be provided on a low-voltage control panel. Typically a pushbutton is used for the trip-open function and, when optional motors are provided a pistol-grip type selector switch is used to allow both open and close operations to be performed electrically. After initiating a trip-open operation, verify that the Manual-Trip Pin on the faceplate of the Vacuum Fault Interrupter has reset to the up position to allow a subsequent closing operation using the Manual-Crank Handle. When the vacuum interrupter has been tripped open, the visible disconnect can be operated, refer to "Visible Disconnect Operation" on page 10.

Visible Disconnect Operation

When the vacuum interrupter or vacuum fault interrupter has been tripped open, the visible disconnect can be operated open and closed. The direction of rotation for open and for close is illustrated on the faceplate of the vacuum interrupter.

a. Interlocking on the Visible Disconnect

The visible disconnect is NOT a load-break device and the disconnect opens at the same speed as its manual operating handle is rotated. Therefore, interlocking is provided (i) to prevent opening the visible disconnect until after the vacuum interrupter has been opened and (ii) to prevent closing the vacuum interrupter until after the visible disconnect is closed. As a result, the circuit is always opened and closed through the vacuum interrupter.

b. Open/Close Operation of the Visible Disconnect

Use the Visible-Disconnect Operating Handle (refer to Figure 15) to open/close the visible disconnect. The direction of rotation for an open or close operation is screened onto the faceplate. Whether opening or closing the visible disconnect, make certain to rotate the handle to the fullest extent possible without exerting excessive force.

Failure to rotate the handle to the fullest extent possible can (i) result in achieving only a limited open gap distance that would reduce the effective BIL below the rated value when the visible disconnect is only partially opened or (ii) result in blocking a subsequent closing operation if the visible disconnect is not completely closed during the closing operation. Verify the closed disconnect position by observing that the blade is fully engaged with the contacts. Verify the open disconnect position by exerting some force, but not an excessive force, on the Visible-Disconnect Handle in the opening direction.

The Visible-Disconnect Handle can be padlocked in the open position by installing a padlock in both the hole on the padlock tab and the hole in the handle. See Figure 15.

OVERCURRENT PROTECTION

Federal Pacific's vacuum fault interrupters response to overcurrents occuring on load-feeder circuits is controlled by either a Self-Powered Relay (see Figure 17) that energizes a magnetic latch to trip the vacuum fault interrupter or by an SEL-501 Dual Universal OCR (see Figure 18) or similar overcurrent relay. The response to overcurrents occuring on main-primary feeder circuits will be covered separately.

Federal Pacific vacuum fault interrupters are trip free. When closed on a fault, the vacuum fault interrupter will immediately open to clear the circuit.

Self-Powered Relay

The self-powered relay in combination with the magnetic latch (on the vacuum fault interrupter) is utilized when vacuum-fault-interrupter operation is to be performed in response to an overcurrent sensed by a current sensing device and is designed to be operated manually in all other cases (an optional motor is available) using the manual operating handle mounted on the side of the pad-mounted switchgear (or the manual trip-open button on the faceplate). Power for the relay is generated by the current transformers used for sensing the overcurrent.

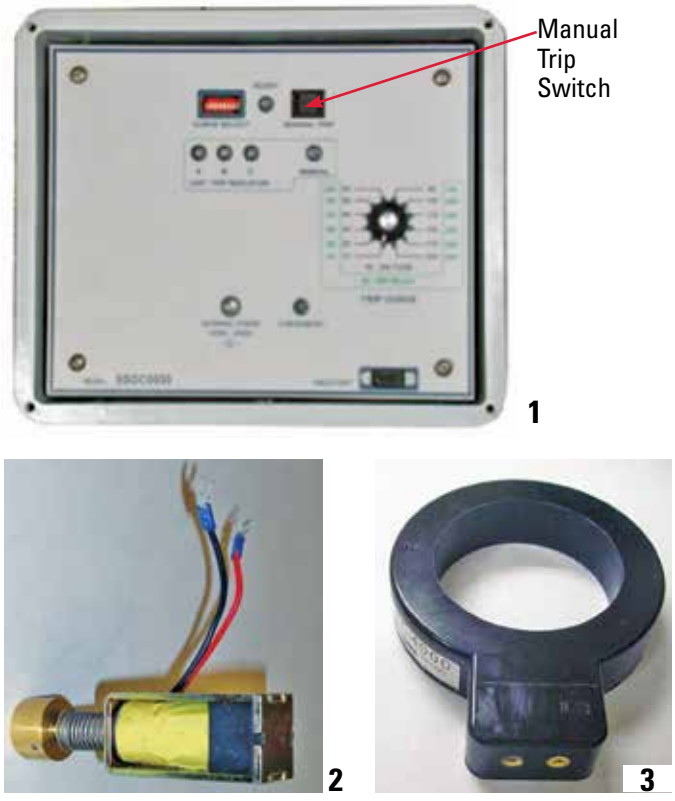


Figure 17a. The self-powered relay components include (1) the relay that provides all the settings and controls necessary to initiate vacuum fault interrupter operations based on the programmed parameters, (2) the magnetic actuator pictured that provides mechanical trip-actuation of (and is mounted on) the vacuum fault interrupter mechanism and (3) the current-sensing transformer that provides sensing and power input to the relay and trip circuit.

Figure 17.b. The Self-Powered Overcurrent Relay is pictured above installed in combination with Vacuum Fault Interrupter (at left) to provide overcurrent protection for a load feeder circuit. Vacuum Interrupter at right is manually operated and provides switching for the main-primary feeder circuit.

Figure 17.c. The Self-Powered Overcurrent Relay is in a weather-resistant enclosure and is mounted on the inside of the low-voltage compartment door that also includes the manual handles for operating the vacuum fault interrupter and the visible disconnect.

Figure 17.d. Current-sensing transformers for the Self-Powered Relay are shown tie-wrapped to the ground bar as arranged for shipment and are to be secured to the cable using heavy-duty tie wraps. Current sensors must be installed below the terminator. The concentric-neutral wires must pass back through the current sensor before being taken to ground as described on page 11.

Overcurrent Relay

The SEL-501 relay (see Figure 18.a.1) is used as an alternate protective relay choice to initiate operation of the vacuum fault interrupter. The vacuum fault-interrupter is operated manually (an optional motor is available).These relays require an external control power source (voltage transformer) and a UPS (battery backup) to insure that power is available during the fault, which otherwise will drop the voltage below the required level for the relay to operate. The relay will be powered by a control-power source, typically a voltage transformer. The SEL-501 relay provides overcurrent response for two vacuum fault interrupters in a single compact package. The relay is readily programmed to provide the specific relay curve that is desired for the particular application.

Overcurrent Sensing

Current transformers (see Figure 18.a.4) provide overcurrent sensing as input to the relay. Reliability of the current transformers has been demonstrated over many years of service in all types of environments from the very hot to the very cold.

Control Power for Overcurrent Relay

A fused voltage transformer (see Figure 18.a.2) is provided to supply control power for the SEL-501 relay. In the event control power is lost, or drops below the minimum level for proper operation of the relay, a UPS backup battery is also provided (see Figure 18.a.3). Actual location of the fused voltage transformer in the switchgear may vary depending on the specific application. See Figures 18c and 24.

1

2

3

4

Figure 18a Overcurrent protection is provided using (1) the SEL-501 Dual Universal OCR, which can handle relay control for two vacuum fault interrupters, as an alternate to the Self-Powered Relay; (2) the fused voltage transformer to provide control power for the relays and any auxiliary components under normal conditions; (3) the Uninterruptable Power Supply (UPS) provides backup power for the relay in the event the normal power source is lost; and (4) current transformers to sense the overcurrent condition and provide that input to the SEL-501 relay.

Figure 18b. Shown above is a view of a typical low-voltage compartment used when the SEL-501 relay, which is mounted on a hinged-bolted panel, is selected as the overcurrent relay to use in the protection scheme. In this case, two relays are required as three (3) load-feeder circuits are involved. The UPS and auxiliary control components are also shown. The photo at bottom shows the interior of the low-voltage control compartment with the hinged-bolted panel swung open.

Installing Current Sensing Devices

Switchgear may be equipped with Current Sensing Devices of various types (e.g. current transformers, current sensors etc.). On pad-mounted switchgear where Federal Pacific supplies an optional overcurrent sensing scheme controlled by a self-powered relay or an overcurrent relay, such as an SEL-451 relay, usually 600 volt class window-type CT's will also be supplied. Federal Pacific will offer a "bracket-supported" window-type CT (see Figure 18c) or a "split core" CT (see Figure 18d). The "split core" type CT is usually to be supported on the cable using heavy-duty tie wraps.

⚠ CAUTION

For correct functioning of the current-sensing scheme, the current transformers (CTs) or current sensors must be positioned below the stress cone, terminator or elbow connector and must be located (around the cable and the concentric neutral ground wires of the cable) in a manner such that any current in the ground wires and cable jacket will be cancelled as it passes through the window of the CT. This can be accomplished by allowing the ground wire to pass through the CT window in one direction and return through the CT window in the opposite direction before being grounded (see Figure 18d). This same statement applies to a "drain wire" coming from the bottom of the terminator through CT window mounted **above** the ending of the concentric neutral wires of the HV cable.

Figure 18c. This view shows an alternate location for a fused-voltage transformer (at arrow). In this installation the VT opening will be covered by a bolted steel panel that includes lifting handles. View also shows "bracket-supported" window-type CTs.

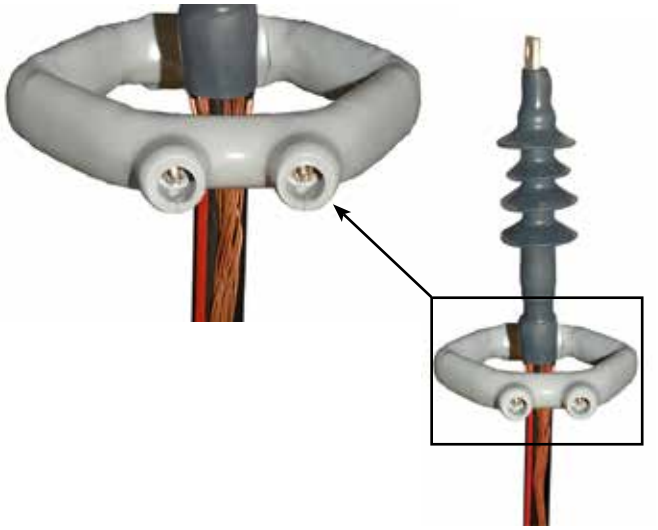


Figure 18d. Current sensors (illustrated) are to be secured to conductor using heavy tie wraps. Note that concentric neutral is insulated (in cable) and passes back through current sensor as bare wire before connection to ground. The same orientation applies when window-type CTs are used and when separable insulated connectors are used to terminate the cable.

MOTOR OPERATORS

For Vacuum Interrupters:

Federal Pacific vacuum interrupters can be optionally equipped with integral motor operators (see Figure 19). When motor operated, the units are suitable for integration with additional appropriate control systems for application in automatic-source-transfer, automatic-sectionalizing, remote-supervisory-control and shut-trip schemes, as well as with overcurrent protection schemes.

Federal Pacific motor operators are installed directly on the frame of the vacuum interrupter. The integrated compact arrangement of motor operators with vacuum interrupters means that very little additional space is required for applications requiring automation.

The optional local open/close functions may be accomplished, for example, using pistol-grip type handles and open/close indicating lamps may be furnished. See Figure 18b. Optional controls are also available to permit motor operation and all tripping functions to be performed from a local but isolated location. By operating the unit by means of an optional local portable control station,concerns over exposure to arc-flash hazards can be eliminated.

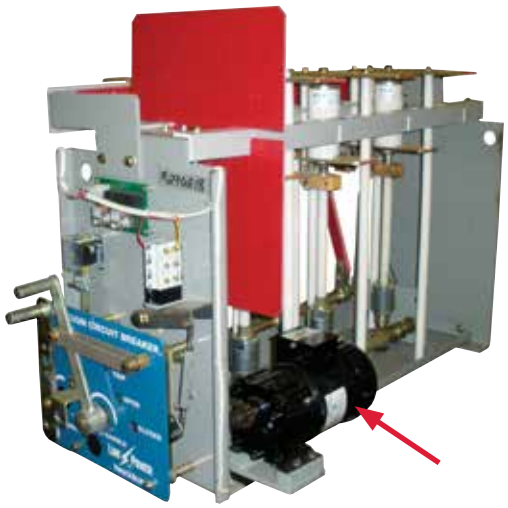


Figure 19. Motor Operators can be added to all Federal Pacific Vacuum Interrupters as pictured at the bottom right on the 15kV Vacuum Fault Interrupter above.

For Auto-jet® II Switches:

Federal Pacific Run-and-Trip and Fast-Trip style motor operators are available for automation of Federal Pacific Auto-jet®II Switches when applied in PVE Models of pad-mounted switchgear. These motor operators can be utilized in combination with the Auto-jet®II Switches in automated-distribution and smart-system applications such as automatic source transfer, remote-supervisory (SCADA) control and automatic sectionalizing and fault isolation (self-healing) switching schemes. Separate instruction bulletins are provided when these motor operators are included on PVE models for motor operation of Auto-jet®II Switches. Refer to the separately provided instruction bulletin for information on operation of the Run-and-Trip and Fast-Trip Motor Operators.

a. Fast-Trip Motor Operators
   The Fast-Trip Style motor operator includes all the same features of the Run-and-Trip except it employs a high-speed, high-torque motor capable of opening (or closing) the Federal Pacific Auto-jet® II Switch in approximately eight (8) to ten (10) cycles from the instant the motor is actuated through to completion of the switching operation. It is similarly employed in combination with the SEL-451 relay in automatic source-transfer applications to achieve an operating time of 15-20 cycles for completion of the transfer operation.

Figure 20. Fast-Trip Style motor operator has a large, high-speed motor and space to accommodate an array of communications and control components similar to that of the Run-and-Trip motor operator. The cover over the motor is interlocked so that when the cover is opened, the motor will not operate to avoid exposure to fast moving parts. Other features are similar to those shown for the Run-and-Trip motor operator.

b. Run-and-Trip Motor Operators

The Federal Pacific Type PM Motor Operator, dubbed the Run-and-Trip motor operator, includes all of the typical features expected on a motor operator used in pad-mounted switchgear, including a decoupler that allows the motor operator to be decoupled from the switch and run the motor without changing the position of switch to verify functionality of the scheme. The operating speed for the Run-and-Trip Style motor operator is approximately 4-5 seconds from the instant the motor is actuated through to completion of the switch opening or closing. Operation can be effected either automatically when combined with an SEL-451 relay for automatic source transfer or remotely when combined with appropriate communication components. Operating time for the automatic source-transfer scheme using the Run-and-Trip motor operator is approximately eight (8) seconds.

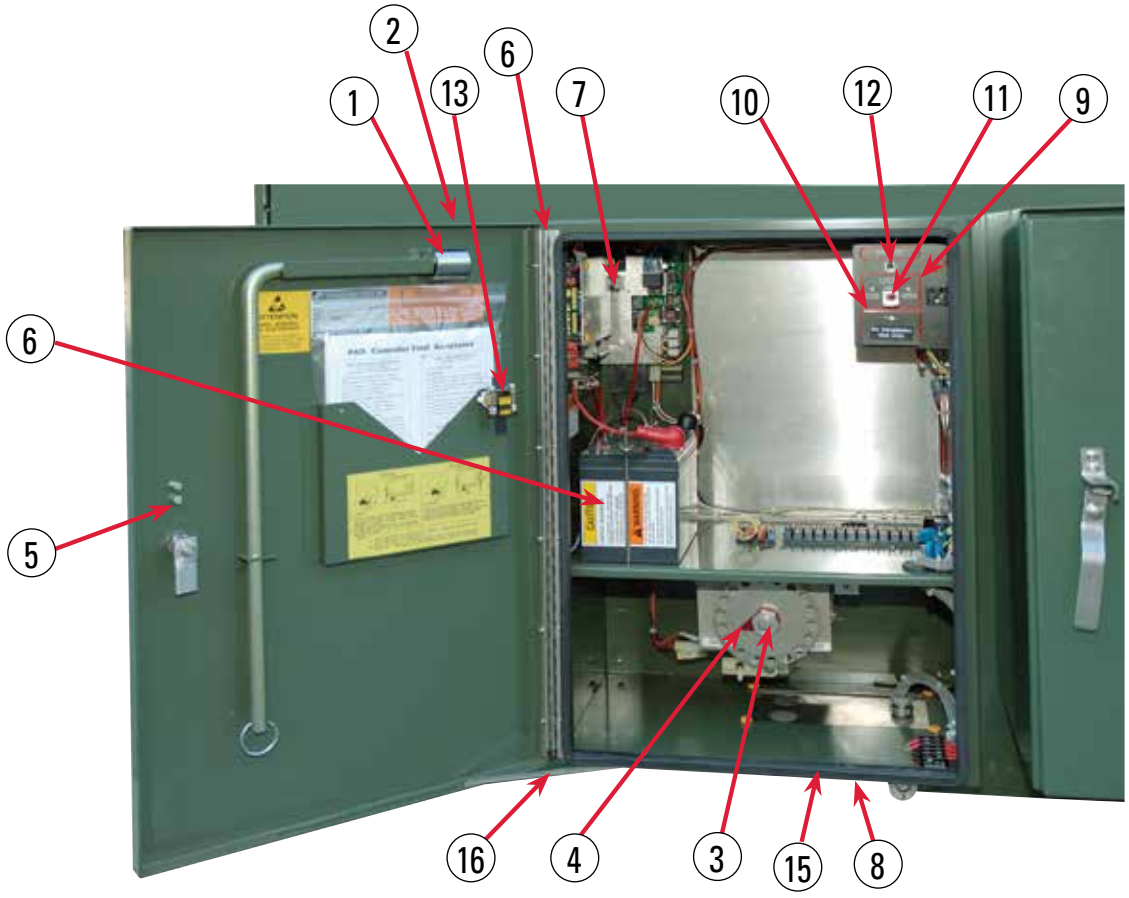


Figure 21. Run-and-Trip Style motor operator provides space for an RTU, radio, antenna, power supply, control power source and associated components. Features shown are also provided on the Fast-Trip motor operator.

1. Switch operator crank handle
2. Aluminum enclosure
3. Switch output shaft
4. Switch position indicator
5. Padlockable stainless-steel handle (not visible)
6. 24V DC battery
7. Battery charger control circuit
8. Removable plate for conduit entry of low-voltage wiring at bottom of enclosure
9. Open/close indicating lamps
10. Operation counter (optional - not shown)
11. Open/close toggle switch
12. Local/remote selector switch
13. Control-source fuses
14. Continuous stainless-steel hinges
15. Gasketed door opening
16 Door holder

EQUIPMENT FEATURES

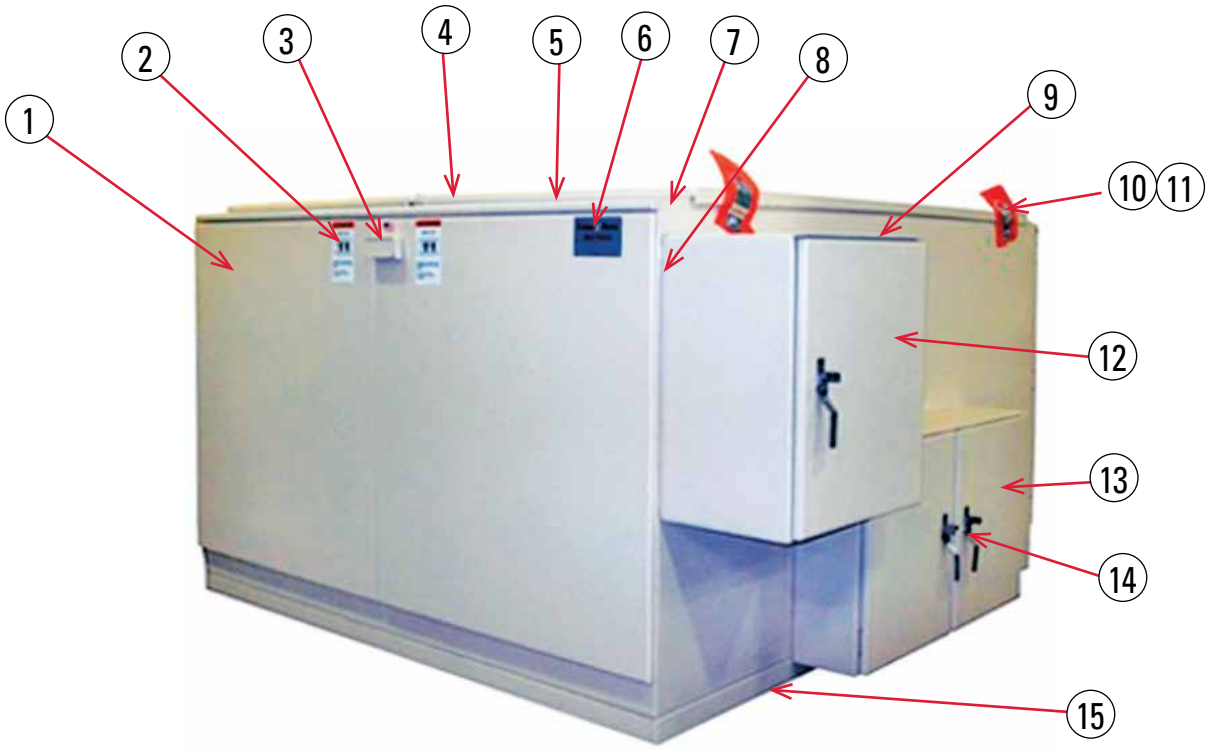


Figure 22. Enclosure Exterior of Federal Pacific PVE Vacuum Interrupter Pad-Mounted Switchgear.

Enclosure Features

1. 11-Gauge Steel Doors
2. Hazard-Alerting Warning Signs On Exterior
3. Hinged, Stainless-Steel Door Lockbox
4. One-Piece, Cross-Kinked 11-Gauge Steel Roof
5. Insulating No-Drip Compound On Underside Of Roof
6. Silk-Screened, Aluminum Stamped Nameplate
7. 11-Gauge Steel Welded Enclosure
8. Control Compartments Sealed To Enclosure
9. Drip-Shield Over Control Compartments
10. Galvanized-Steel Lifting Brackets
11. Closed-Cell Cushions Isolate Enclosure From Lifting Bracket
12. Vacuum-Interrupter Electronic-Control Compartment
13. Vacuum-Interrupter Manual-Control Compartments
14. Stainless-Steel Handles On Control Compartments
15. Closed-Cell Gasket At Bottom Isolates Enclosure From Mounting Surface

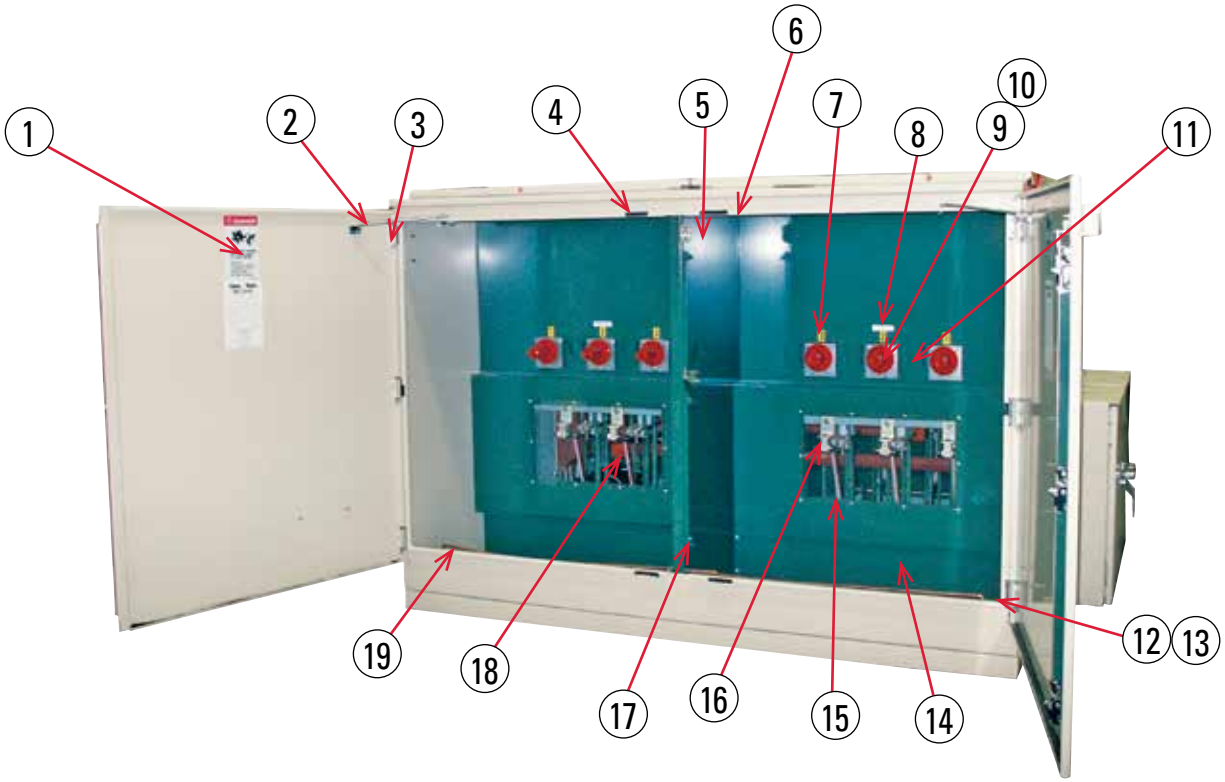


Figure 23. Incoming Termination Compartments — Vacuum Interrupter Switched Ways are illustrated.

Termination Compartment Features - Incoming

1. Hazard-Alerting Danger Signs on Interior
2. Stainless-Steel Windbrace
3. Three (3) Stainless-Steel Hinges and Hinge Pins Per Enclosure Door
4. Bumper Gasket Cushions Door Interface, Prevents Metal-To-Metal Contact
5. Center Steel Divider Isolates Termination Compartments
6. Closed-Cell Gasket Seals Roof to Equipment-Mounting Panel (not visible)
7. Phase Identification Labels
8. Compartment Identification Labels
9. 600 Ampere Cycloaliphatic Epoxy Bushings with All-Copper Conductor on Stainless-Steel Clamping Bracket
10. Removable Silver-Plated All-Copper Stud (not visible) on All Bushings with Red Protective Dust Covers
11. Stainless-Steel Parking Stand for Each Bushing
12. Cross-Kinked, Galvanized-Steel Floor Plate Isolates Vacuum Interrupters and Bus (not visible)
13. Stainless-Steel Screened 1" Vent (not visible) In Each Corner of Floor Plate Allows Any High Ground Water or Flooding to Drain Out
14. Formed-Steel Equipment-Mounting Panels (not visible) Isolate High-Voltage Components from Termination Compartments
15. Wide-View Clear Polycarbonate Window for Viewing Visible Disconnect on Vacuum Interrupters
16. Vacuum Interrupter Switches (load-break only)
17. Stainless-Steel Door-Latch Pins
18. Visible Disconnects for Vacuum Interrupter Switches
19. Continuous Ground Bus in Termination Compartments

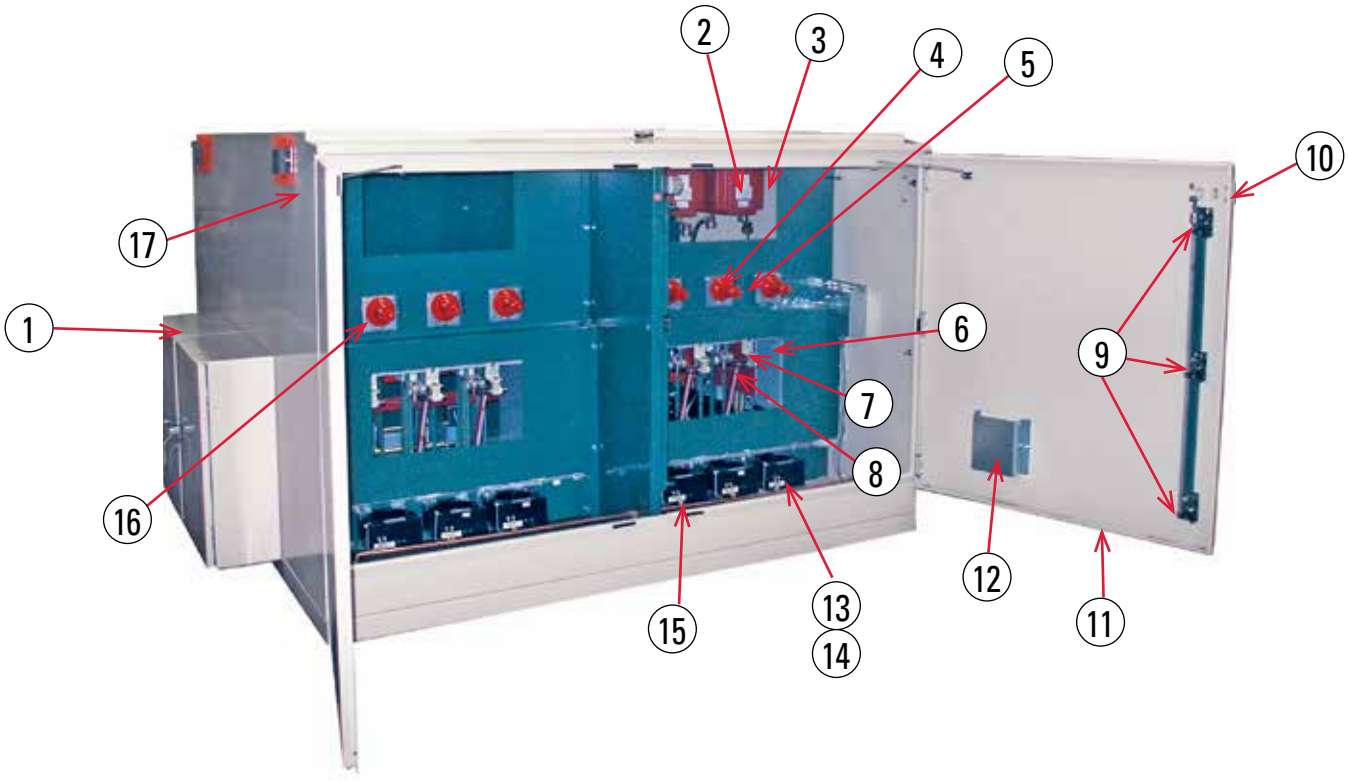


Figure 24. Load-Feeder Termination Compartments of Vacuum Fault-Interrupter Protected Ways.

Termination Compartment Features - Outgoing

1. Compartments Provide Access to Manual-Operating Handles of Vacuum Interrupters
2. Fused-Voltage Transformers for Sensing and Control Power For Vacuum Fault Interrupters (equipped with other than a self-powered relay or when motor operated). Alternate mounting locations may apply depending on specification requirements. See Figure 18c.
3. Viewing Window Provides Visibility and Access to Fused-Voltage Transformers
4. 600 Ampere Bushings for Fault Interrupters
5. Stainless-Steel Mounting Plate and Parking Stand for Each Bushing
6. Viewing Windows for Fault Interrupters
7. Vacuum Fault Interrupters
8. Visible Disconnect for Vacuum Fault Interrupters
9. Self-Latching and Resetting Three-Point Door Latches
10. Penta-Head Actuated Self-Latching Door Operating Mechanism. Cover over penta-head bolt is of stainless steel.
11. Undercoating is Applied in Door-Flange Channel, Which Includes Drain Holes, to Provide Protection Against Accumulation of Contamination and Moisture
12. Storage Pocket
13. Current Transformers for Overcurrent Sensing on Vacuum Fault Interrupters (type furnished varies depending on specification)
14. Optional Split-Core Current Sensors for Overcurrent Sensing Are Available As An Alternate.
15. Continuous Copper Ground Bus Across Door Opening of Load-Feeder Termination Compartments
16. Optional 200 Ampere Bushing Wells to Replace 600 Ampere Bushings are Available As An Alternate.
17. Optional Mounting Provisions for Fault Indicators (not visible)

Vacuum Interrupter - Features

1. Faceplate Is Silk Screened for Permanent Labeling (See Figure 15)
2. Visible-Disconnect Manual-Operating Handle
3. Vacuum Interrupter Manual-Operating Handle
4. Manual Trip-Open Operating Button
5. Vacuum Interrupter Open/Closed Position Indicators
6. Padlock Tab For Visible-Disconnect Manual-Operating Handle
7. Overcurrent Relay
8. Optional Motor Operator
9. Isolating Fiberglass Barrier
10. Vacuum Fault Interrupter
11. Insulated Phase Supports
12. Contact-Pressure Counter-Weight
13. Steel Mounting Frame
14. Undervoltage Relay
15. Shunt-Trip Relay

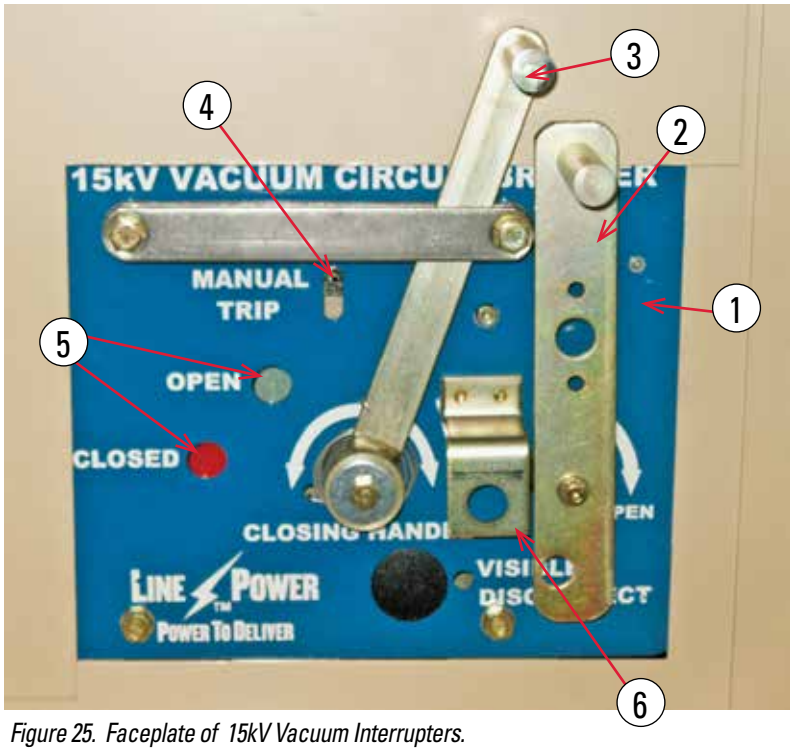


Figure 25. Faceplate of 15kV Vacuum Interrupters.

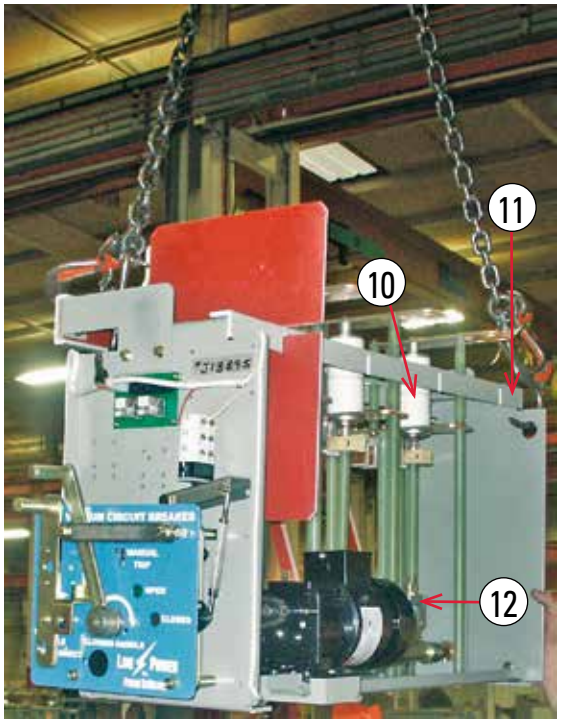


Figure 26. 15kV Vacuum Fault Interrupter With Optional Motor Operator.

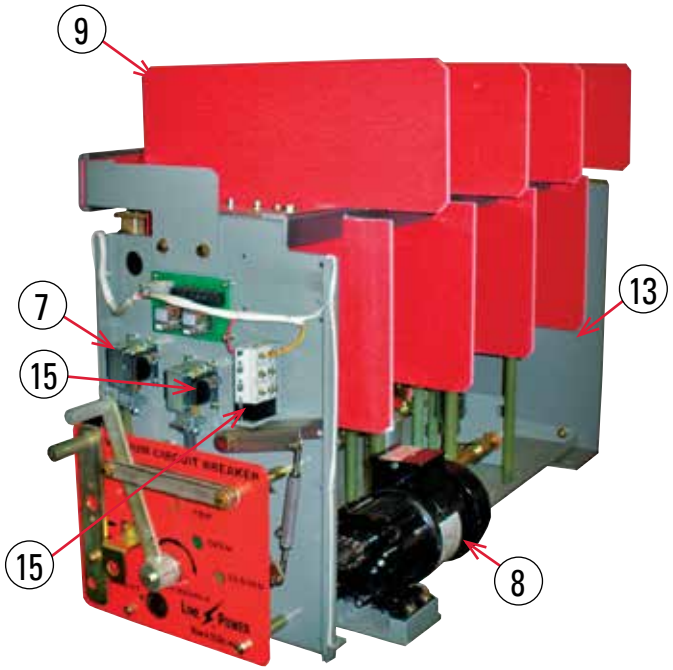


Figure 27. 27kV Vacuum Fault Interrupter With Optional Motor Operator.

Visible Disconnect - Features

1. Vacuum Bottle
2. Disconnect Blade Closed
3. Visible-Disconnect Operating Link
4. Stationary Contact for Visible Disconnect
5. Disconnect Blade Open
6. Visible-Disconnect Operating Shaft (not visible) is connected at bottom to Operating Link

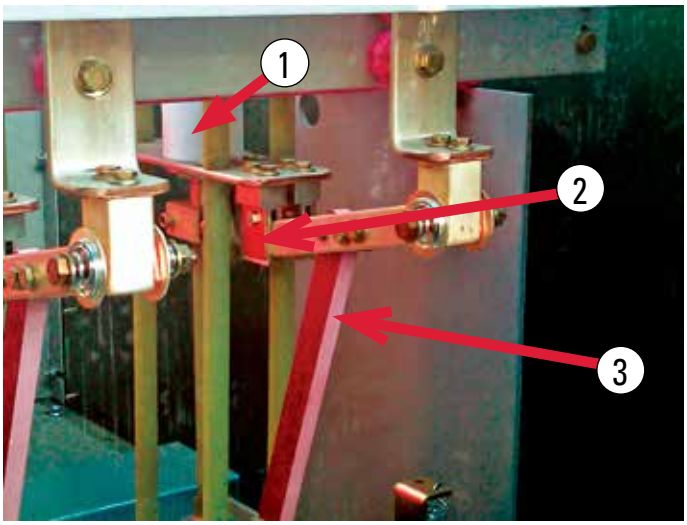


Figure 28a. Integral Visible Disconnect – Disconnect Closed.

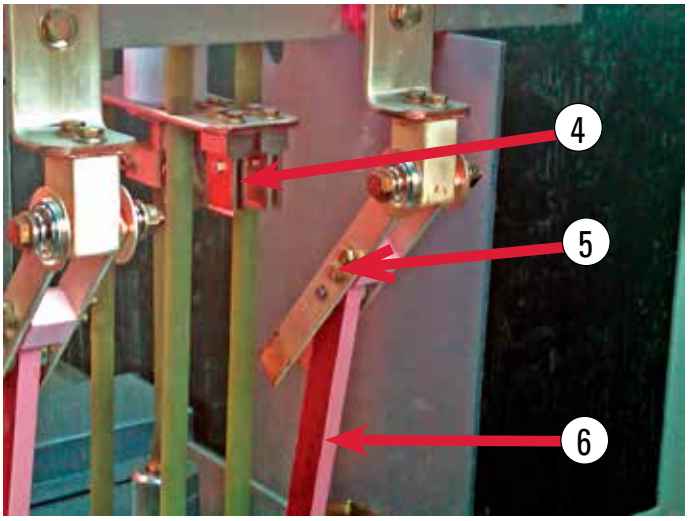


Figure 28b. Integral Visible Disconnect – Disconnect Open.

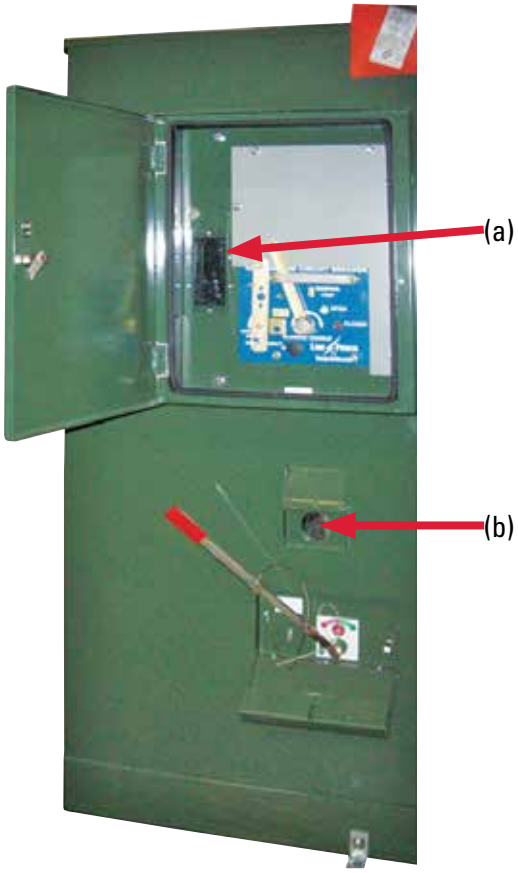


Figure 29. View shows alternate viewing window locations (a) for a vacuum interrupter and (b) for an Auto-jet® II load-interrupter switch, allowing visual verification of actual position of visible disconnect blades and swtichblades.

Low-Voltage Control Compartment - Features

1. Fully Gasketed Door Opening on Low-Voltage Control Compartments
2. Stainless-Steel Hinges and Hinge Pins on Control Compartment Doors
3. Self-Latching Wind Brace
4. Stainless-Steel Hinges and Hinge Pins on Relay Panel
5. Hinged Relay Panel Allows Easy Access to Internal Wiring and Components
6. Captive Wing Nut Secures Relay Panel Closed
7. Elevated Component Mounting Plate Eliminates any Contact with Moisture
8. Heavy 11-gauge Steel Enclosure
9. Heater for Compartment Interior (not visible)
10. Internal Thermostat (not visible)
11. Internal Humidistat (not visible)

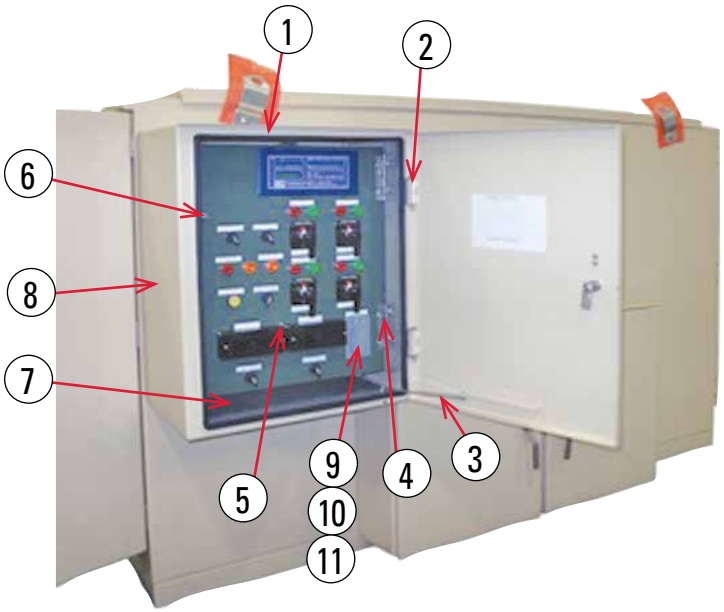


Figure 30. Features of Low-Voltage Enclosure for Relay and Controls. Configuration varies depending on specified requirements and relay used (shown with SEL 501 relay). See Figure 18b for an alternate layout of a low-voltage compartment with overcurrent relays.

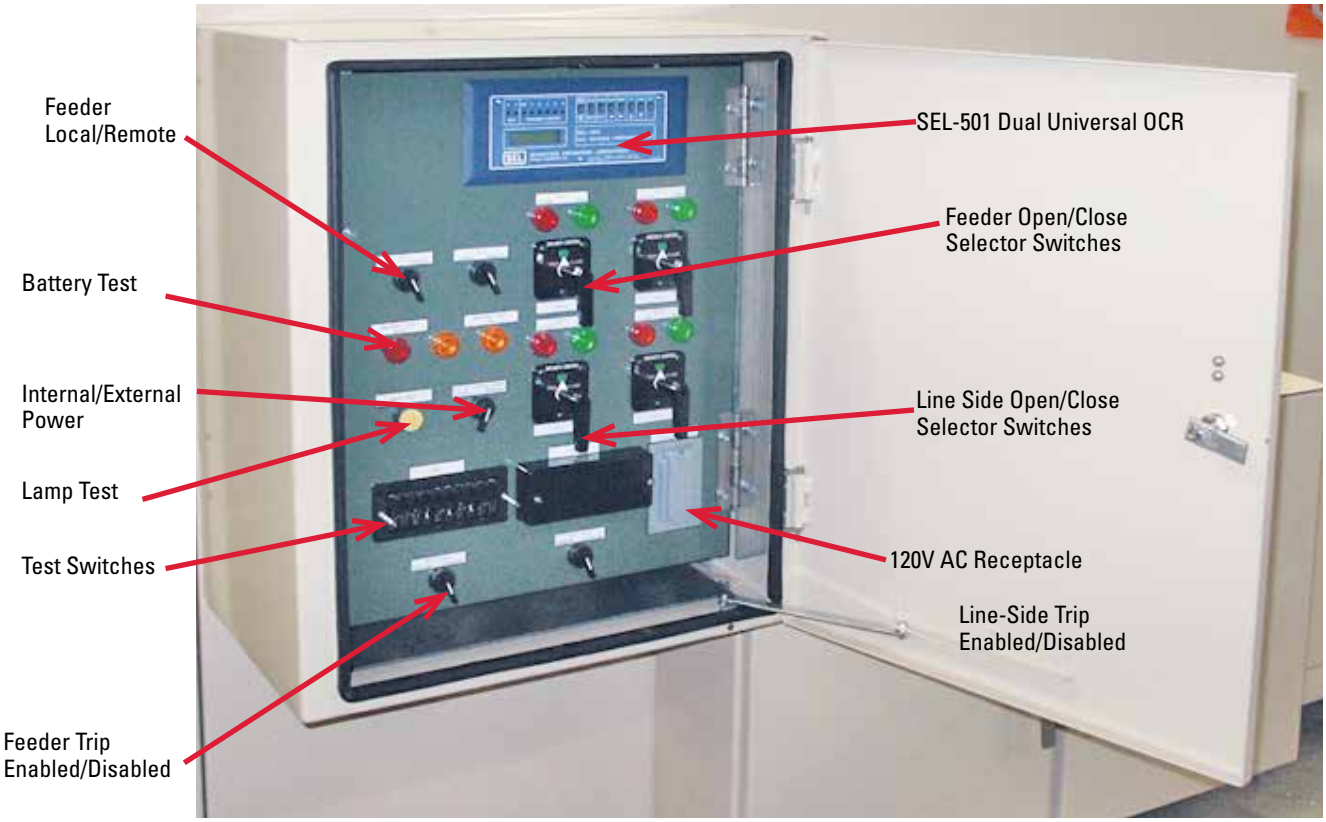


Figure 31. Relay and Control Compartment Component Identifications. Configuration varies depending on specified requirements and relay used (shown with SEL-501 relay). See Figure 18b for an alternate layout of a low-voltage compartment with overcurrent relays.

AUTO-LATCH DOOR

The Type PVE pad-mounted switchgear incorporates a passive door, which includes a latch bracket for securing it closed, and (overlapping the passive door) an active door, which includes an automatic three-point latching system for enclosure security. The features and operation of the auto-latch door are discussed below.

Auto-Latch Door Features

The automatic door latching feature furnished on the main doors provides ease in opening and closing of the doors. Features of the Auto-latch system are:

- Automatic 3-point latching upon door closure (see Figure 32a).
- After opening, the door is automatically set for latching upon door closure.
- Unlatching is only accomplished by an unrestrained rotation (approximately 60° in either direction) of the captive penta-head or hexhead actuator bolt. **DO NOT USE POWER TOOLS ON THIS BOLT.**
- The door padlocking provision prevents unlatching the mechanism until the padlock has been removed. Padlocking secures the door to the cabinet enclosure.
- A stainless steel protective cover guards the padlock from tampering. Also, access to and visibility of, the actuator bolt is only possible after the padlock has been removed.

Figure 32a. Auto-latch mechanism with 3-point latching on door closure.

Figure 32b. Release passive door by simultaneously pushing on it and raising the latch bracket.

Figure 33. Raise cover to access security bolt. DO NOT USE POWER TOOLS ON THIS BOLT.

Figure 34. Wrench with pentahead socket or hexhead socket as applicable. Rotate bolt clockwise or counter-clockwise to release three-point latch and charge for subsequent door closing. DO NOT USE POWER TOOLS ON THIS BOLT.

Auto-Latch Door Operation

Opening:

1. Remove padlock and raise protective cover exposing security bolt. See Figure 33.
2. **DO NOT USE POWER TOOLS ON THIS BOLT.** Using a standard 3/4 inch socket for (optional) hexhead security bolt or penta-head socket for standard penta-head security bolt, rotate the captive actuator bolt head approximately 60° in either direction until latching mechanism has tripped. See Figure 34.
3. Open the active door. Open the passive door by simultaneously pushing on the door and pulling up on the latch bracket. See Figure 32. Secure the doors with the doorkeepers.

Closing:

1. Replace or release door keeper and close and secure latch bracket onto passive door. Then, release and replace door keeper and secure the active door by firmly and briskly pushing it closed. Mechanism will automatically latch.
2. Install padlock through protective cover tab and enclosure tab.

MAINTENANCE

Federal Pacific Pad-mounted Switchgear does not normally require routine mechanical or electrical maintenance. However, the following are some recommendations for enhancing continued service of the equipment.

1. Yearly mechanical exercising of the switch and vacuum interrupters is recommended.

⚠ WARNING

The switchgear must be completely de-energized from all sources before any attempt is made to enter switchgear.

2. Check for cleanliness generally, but particularly for accumulation of any foreign material on insulators.

⚠ WARNING

Do not put grease on switch probe or puffer.

3. If the switch or vacuum interrupter is closed into a short circuit within the making capacity rating and the short circuit is cleared by a vacuum fault interrupter, the unit should not sustain damage that will require major repairs. However, the switch should be inspected before returning to service to determine switch condition.

OPTIONAL FEATURES

Standard options may have been supplied that best serve the customer's needs and operating practices. These are listed below and, if included will be identified by corresponding suffixes to the catalog number.

- *Base Spacer (option suffixes A2 through A9; AS for stainless steel base spacers) Non-compartmented or compartmented*
- *Finish color (option suffix F3)*
- *Stainless steel enclosure exterior (option suffix F4)*
- *Hex-head security bolts (option suffix H)*
- *Key interlocks (option suffixes K1 through K4)*
- *Cable supports (option suffixes T3 and T4)*
- *Fault indicators (option suffixes T6 and T7)*
- *Copper bus (option suffix C)*

SPECIFICATIONS

Vacuum Interrupter Ratings

Applicable Standard	Maximum Voltage Class, kV	Frequency, Hertz	Lightning Impulse Withstand, (BIL) kV	AMPERES							
				Main Bus Continuous	Vacuum Fault Interrupter			Vacuum Interrupter Switch			1-Second Sym.
					Continuous Load Switching and Loop Switching①	Fault Closing, Sym.	Fault Interrupting, Sym.	Continuous Load Switching Loop Switching①	Fault Closing, Sym.	Fault Interrupting, Sym.	
C37.60	15	50/60	95	600	600	12,500	12,500	600	12,500	2,000	12,500
				1200	1200	18,000	18,000	1200	18,000	18,000	18,000
	27	50/60	125	200	200	12,500	12,500	200	12,500	12,500	12,500
				600	600	12,500	12,500	600	12,500	12,500	12,500

① Units rated 200 amperes are furnished with 200-ampere bushing wells for connection of 200-ampere loadbreak inserts and separable insulated connectors. Vacuum Fault Interrupters and Vacuum Interrupter Switches are rated 600 amperes.

Auto-jet® II Switch Ratings

kV			Amperes, RMS					
Voltage Class	Max. Des.	BIL	Cont.	Interrupting			Momentary, Short-Circuit & 3-Time Fault-Close (ASYM kA) ①②	Peak kA
				Load	Cap.	Mag.		
15	17.5	95	600	600	10	21	22.4 or 40	36.4 or 65
25	29	125	600	600	10	21	20 or 40	32 or 65

① The standard rating provided is the first value shown on each line and the second value shown is the High Fault Current (HFC) value that is available as an optional choice. Applicable standard is C37.74.
② The three-time duty-cycle fault-closing rating means that the switch can be closed three times into rated fault amperes and remain operable and able to carry and interrupt its rated load current.

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